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Sarrine et al.

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[45] **Date of Patent: May 9, 1989**

[54] **AUTOMATIC PIPETTING APPARATUS**

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[73] Assignee: **Helena Laboratories Corporation**, Beaumont, Tex.

[21] Appl. No.: **89,025**

[22] Filed: **Aug. 24, 1987**

Related U.S. Application Data

[63] Continuation of Ser. No. 853,201, Apr. 17, 1986, abandoned.

[51] **Int. Cl.**[4] **B01L 3/02**

[52] **U.S. Cl.** ..... **73/864.21**; 204/299 R; 422/102; 422/70; 210/198.3

[58] **Field of Search** ..... 73/863.31, 863.32, 863.01, 73/863.33, 864.21; 204/299 R, 182.7, 182.8, 182.9; 422/102, 62, 69, 70, 55, 100, 56, 68.02, 68.08, 63, 67; 436/169; 210/198.3, 658; 435/815

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Primary Examiner—Stewart J. Levy
Assistant Examiner—Robert R. Raevis
Attorney, Agent, or Firm—Dodge, Bush & Moseley

[57] **ABSTRACT**

An automatic pipetting apparatus is disclosed having a base on which is mounted a vertical frame supporting a row of positive displacement pipettes which are driven in the up or down direction by an electromechanical mechanism under microprocessor controls. The apparatus includes a base, a track and a carriage longitudinally movable beneath the row of pipettes. The carriage includes an independent translating and position signal generation mechanism. The carriage carries a tray which includes sample chambers, a space to receive a microporous electrophoresis support medium, such as a cellulose acetate strip, a wash well, rinse well and a space to receive blotting paper. The pipettes include a barrel and a plunger capable of aspirating and dispensing from 0.5 to 5 μl of liquid. The barrels move up and down with respect to the base by means of another independent translating and signal generating mechanism. The barrels may be easily replaced from the mechanism if they become damaged or worn from many operating cycles. The apparatus under microprocessor program control, washes, rinses, blots the barrels before and after each application or engagement of the barrels with a liquid or contaminant.

32 Claims, 10 Drawing Sheets

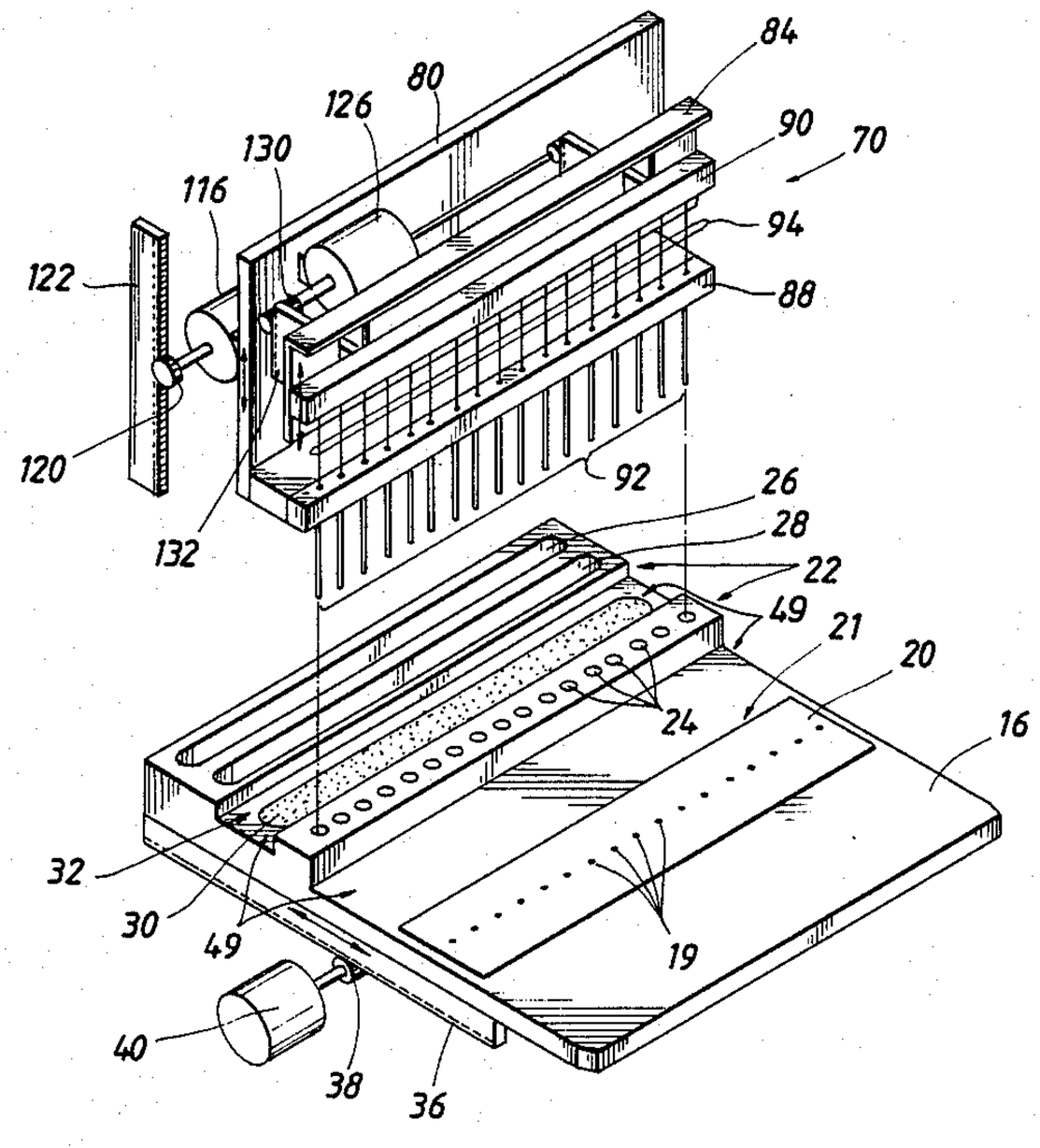
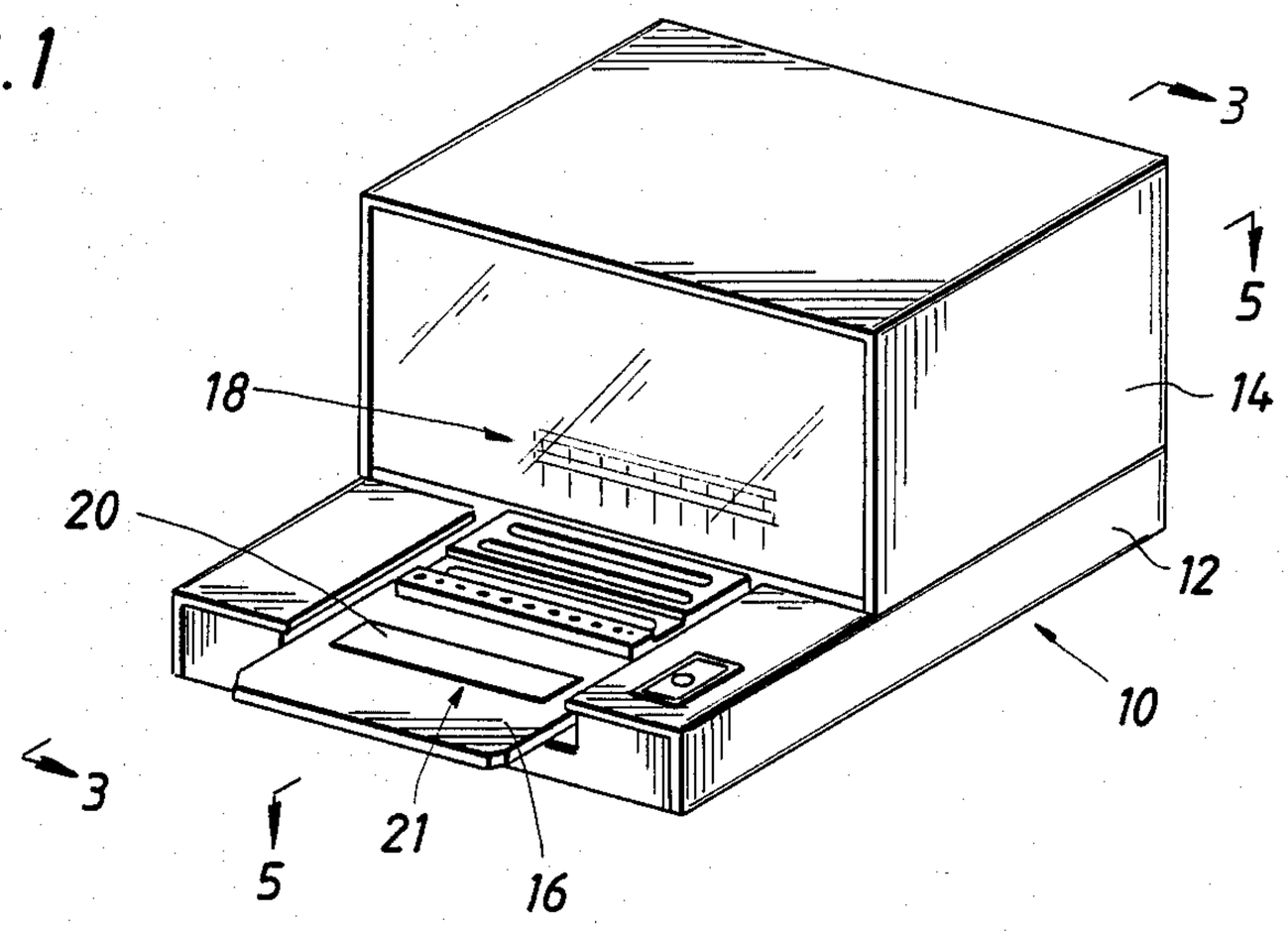


FIG. 1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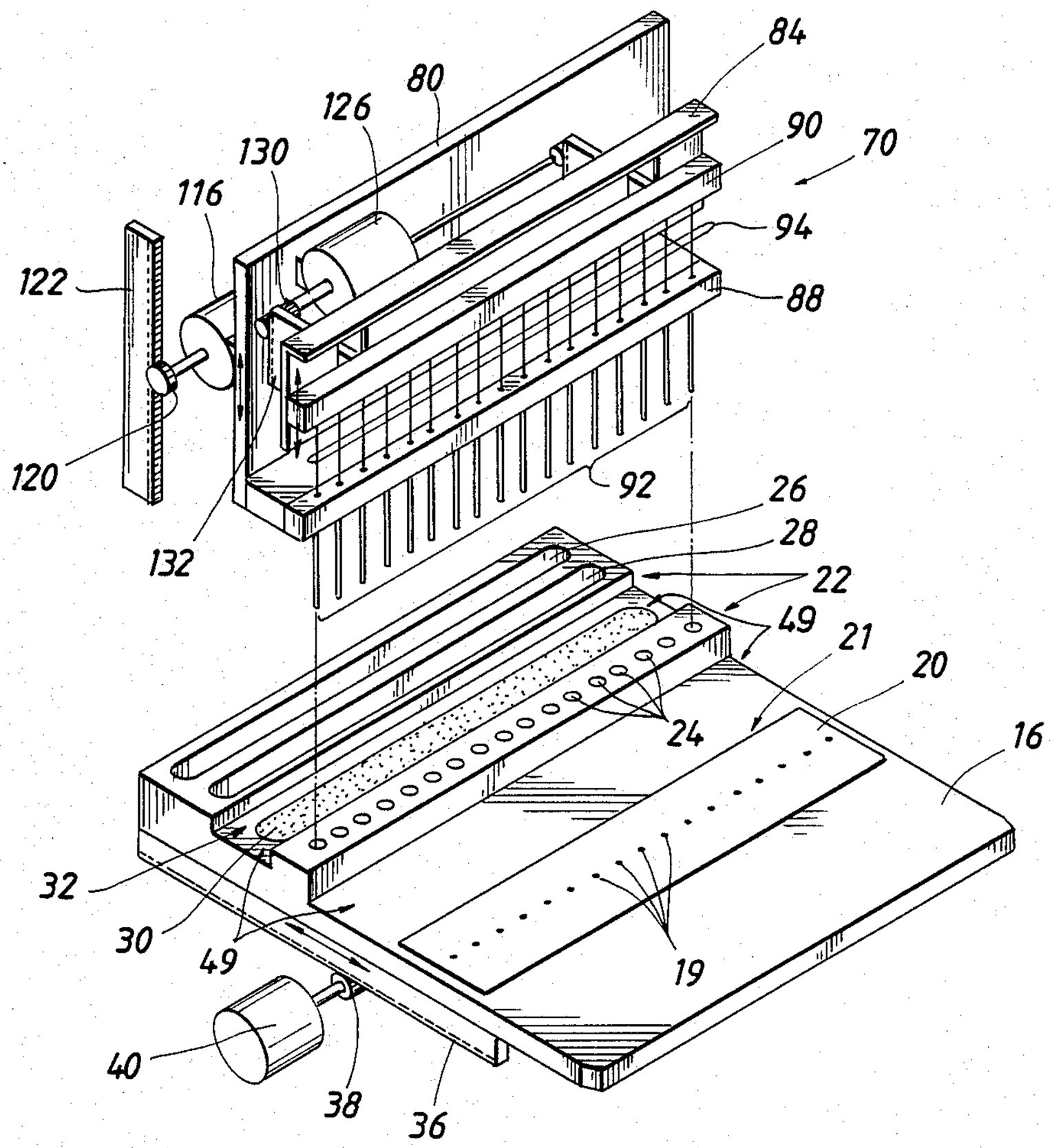
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FIG. 2

FIG. 2A

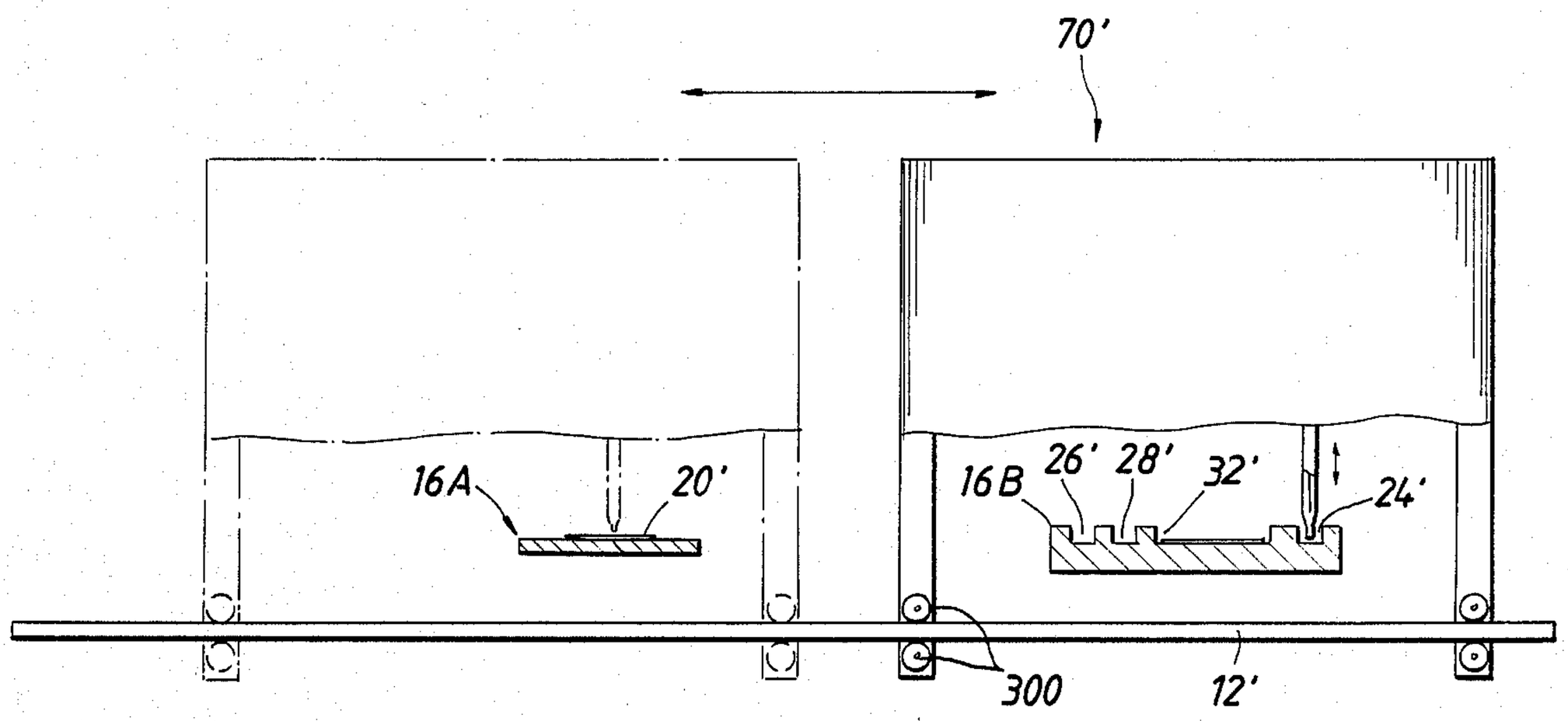
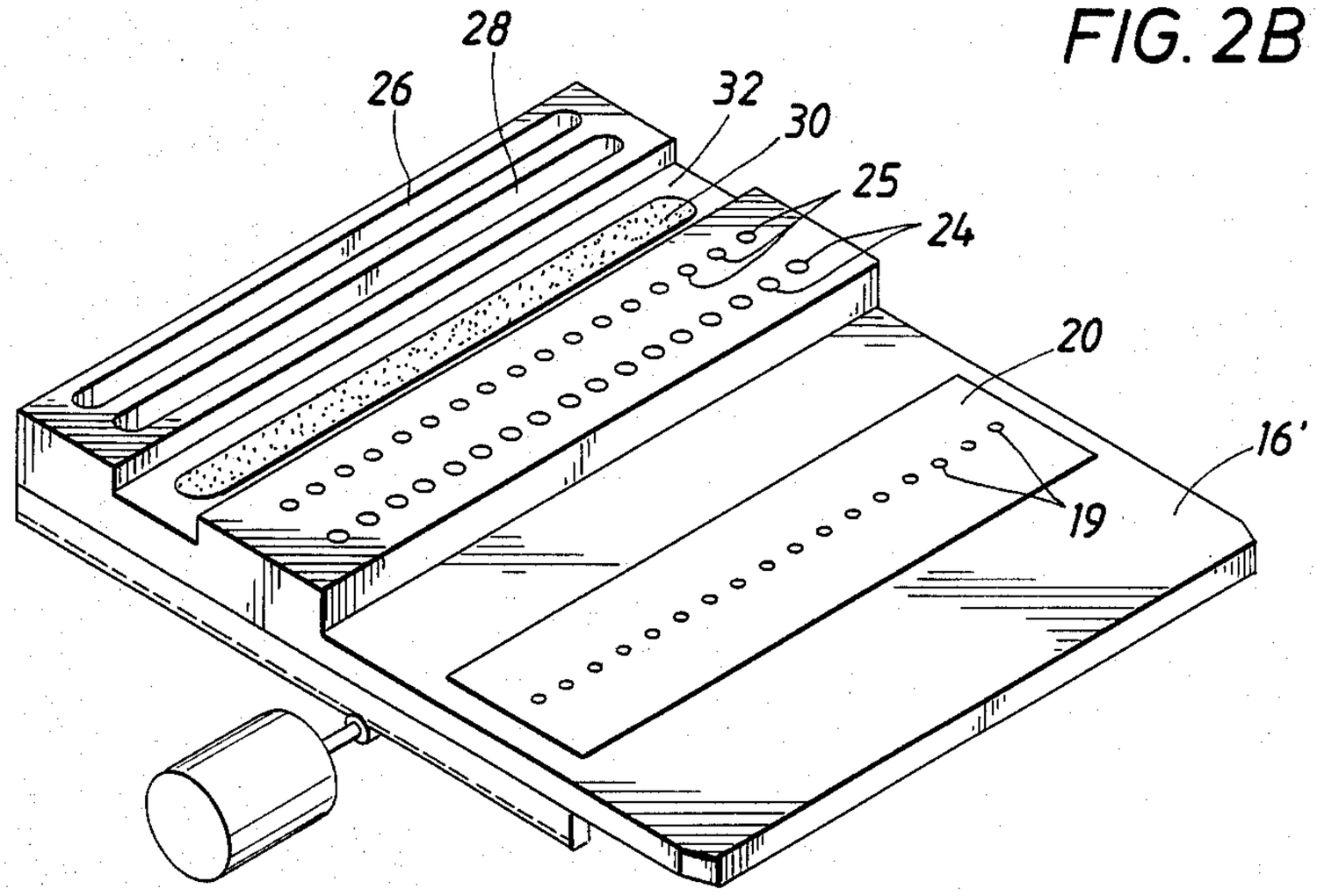


FIG. 2B



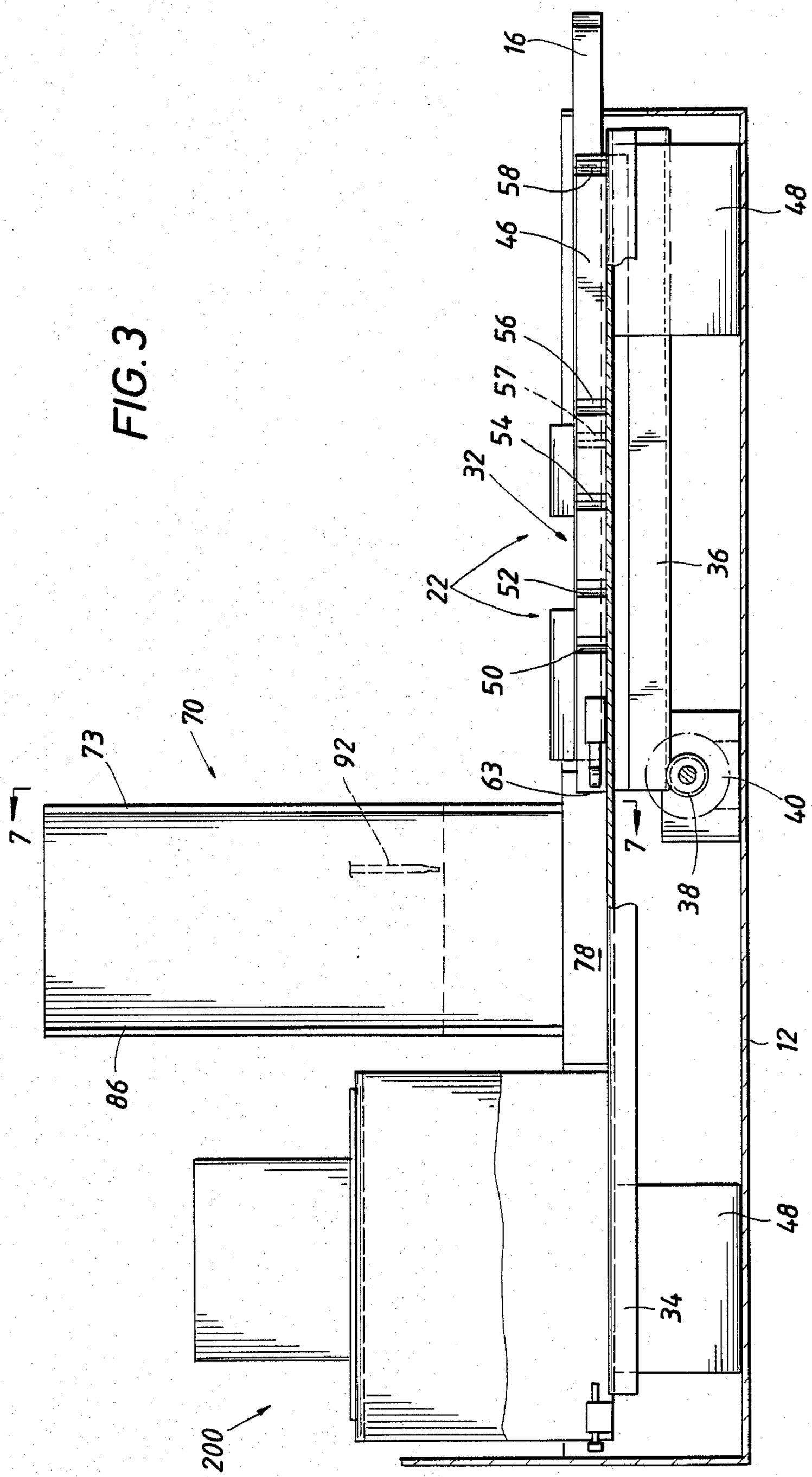

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FIG. 3

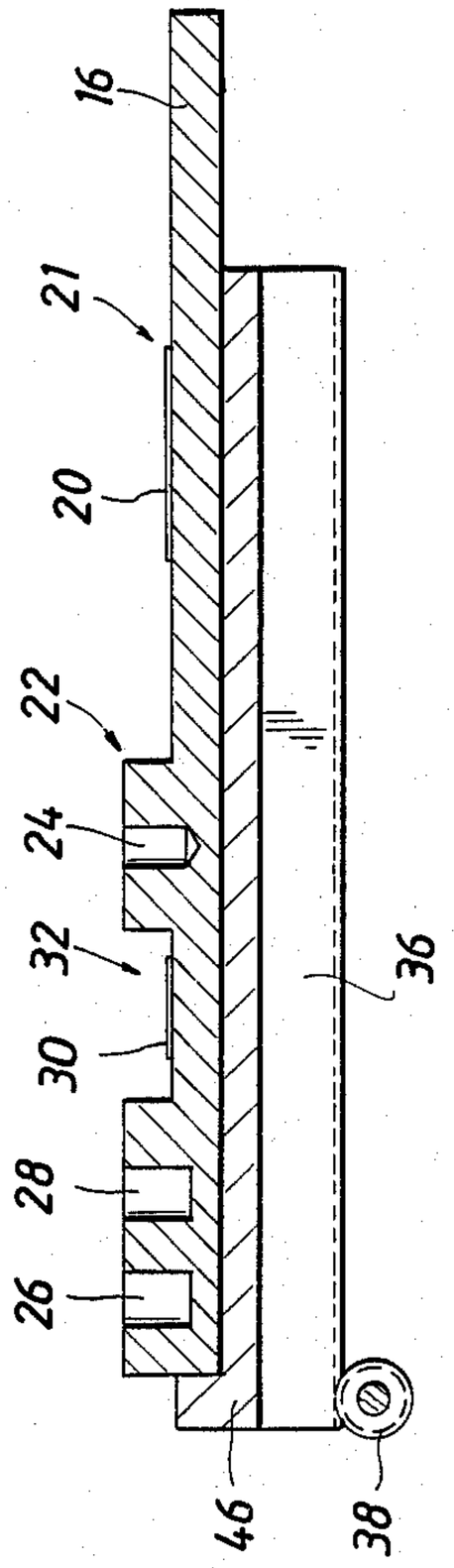
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FIG. 4

FIG. 5

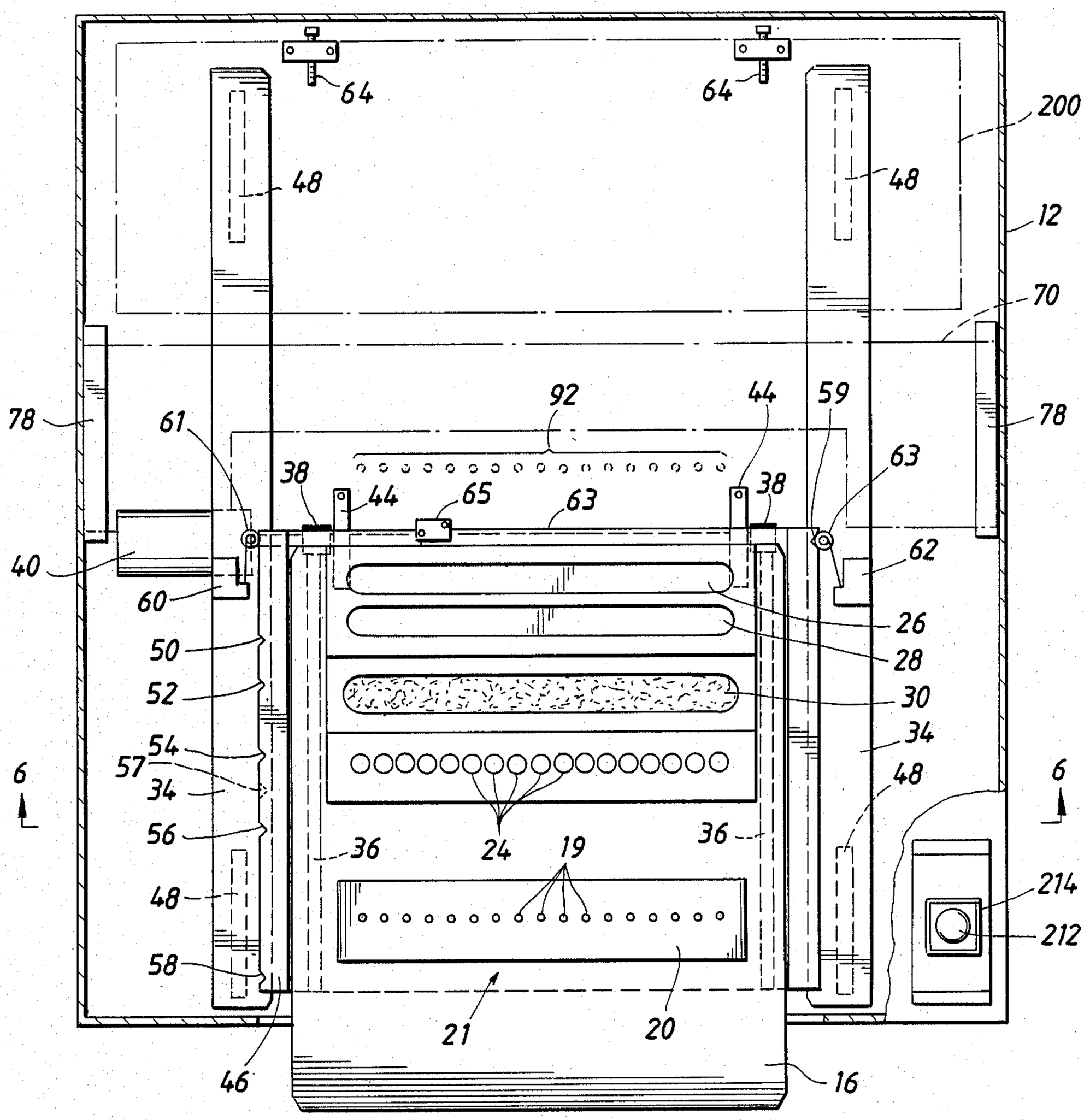
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FIG. 6

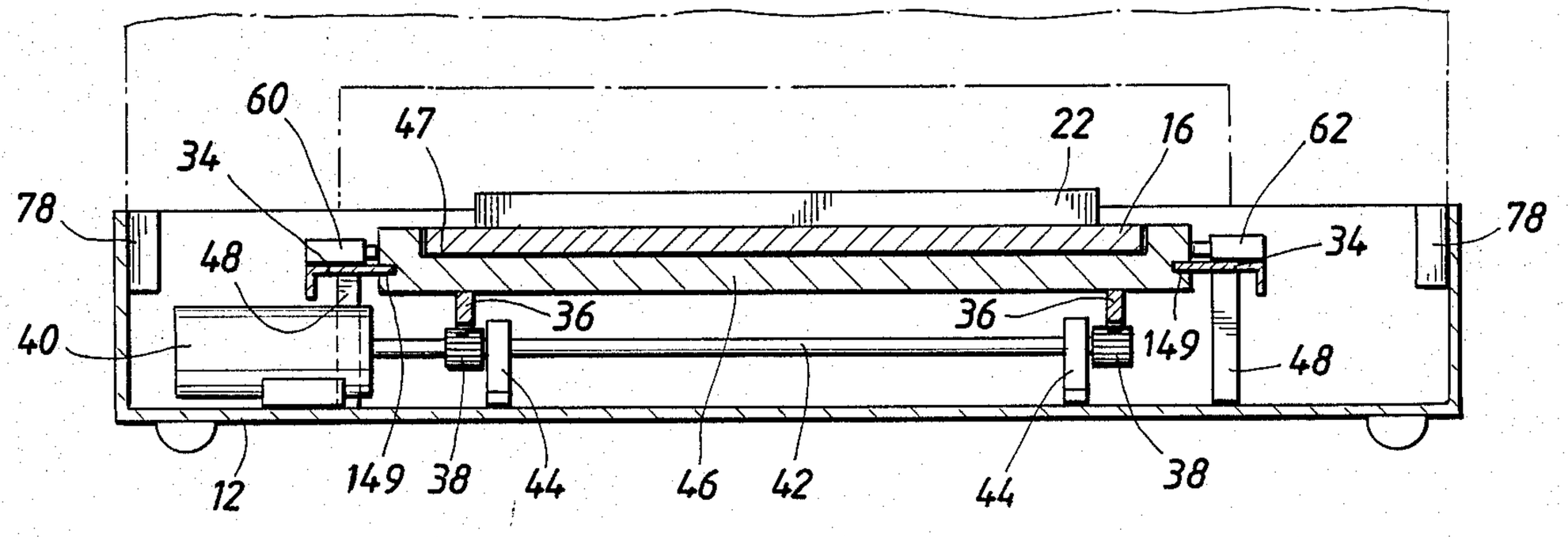
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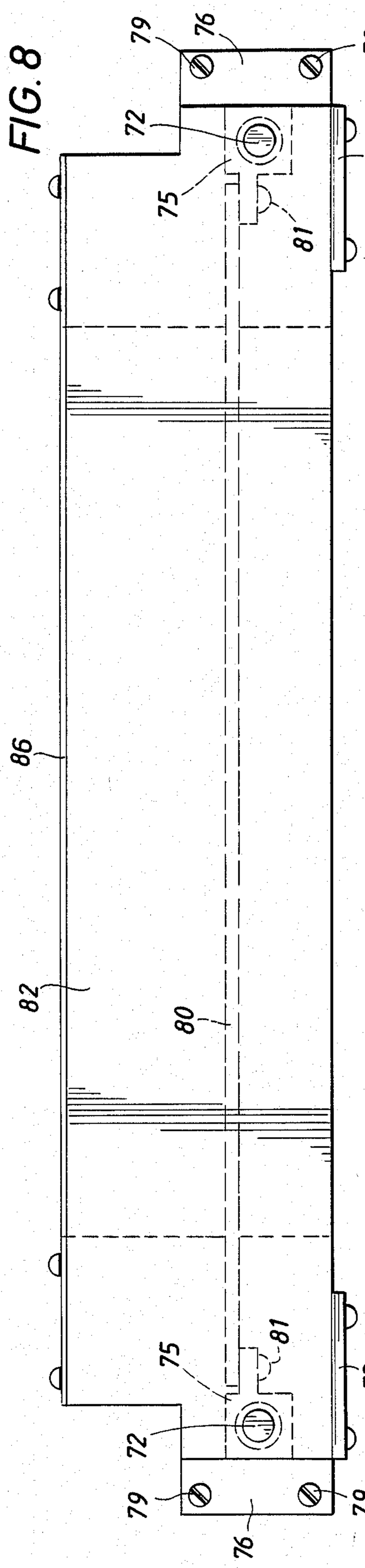
FIG. 8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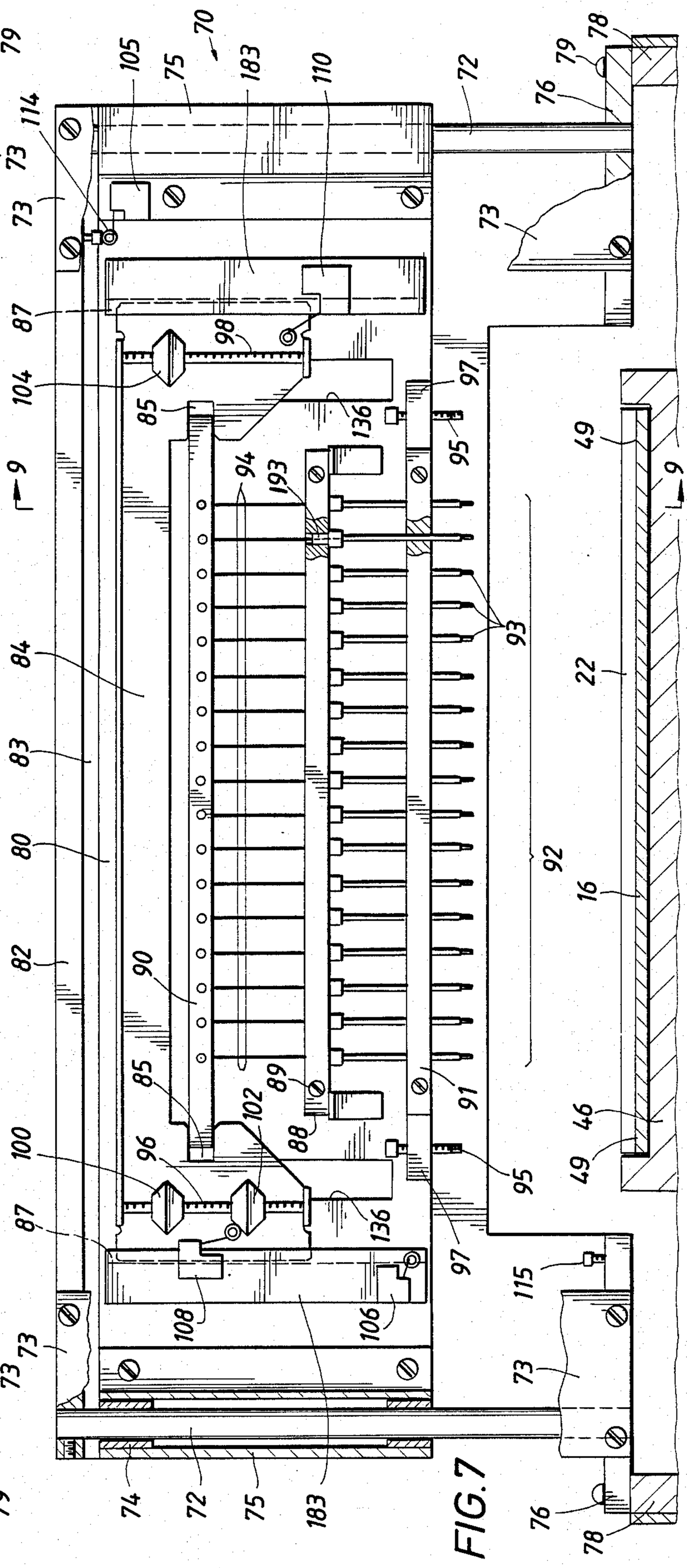
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FIG. 7

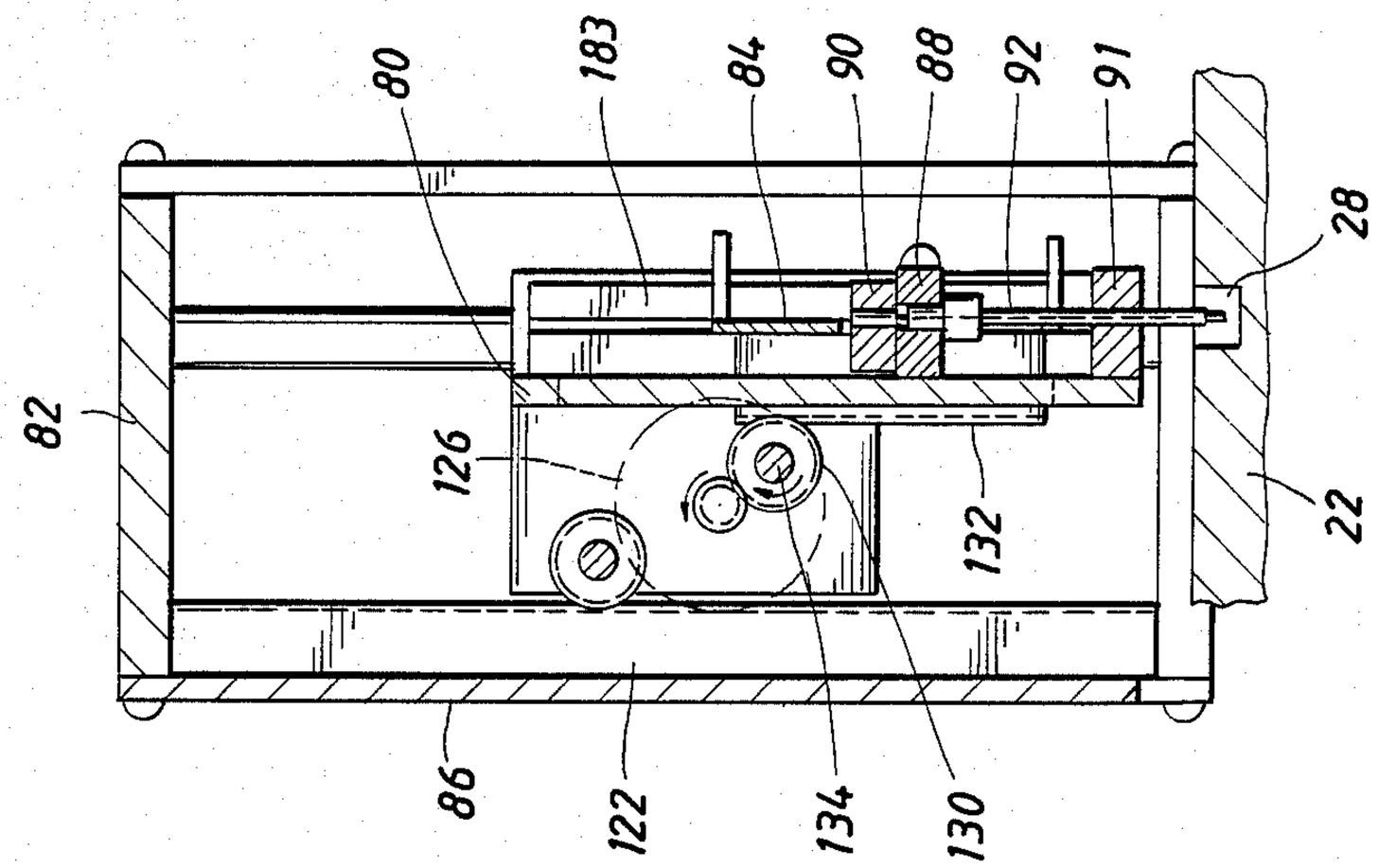

FIG. 15

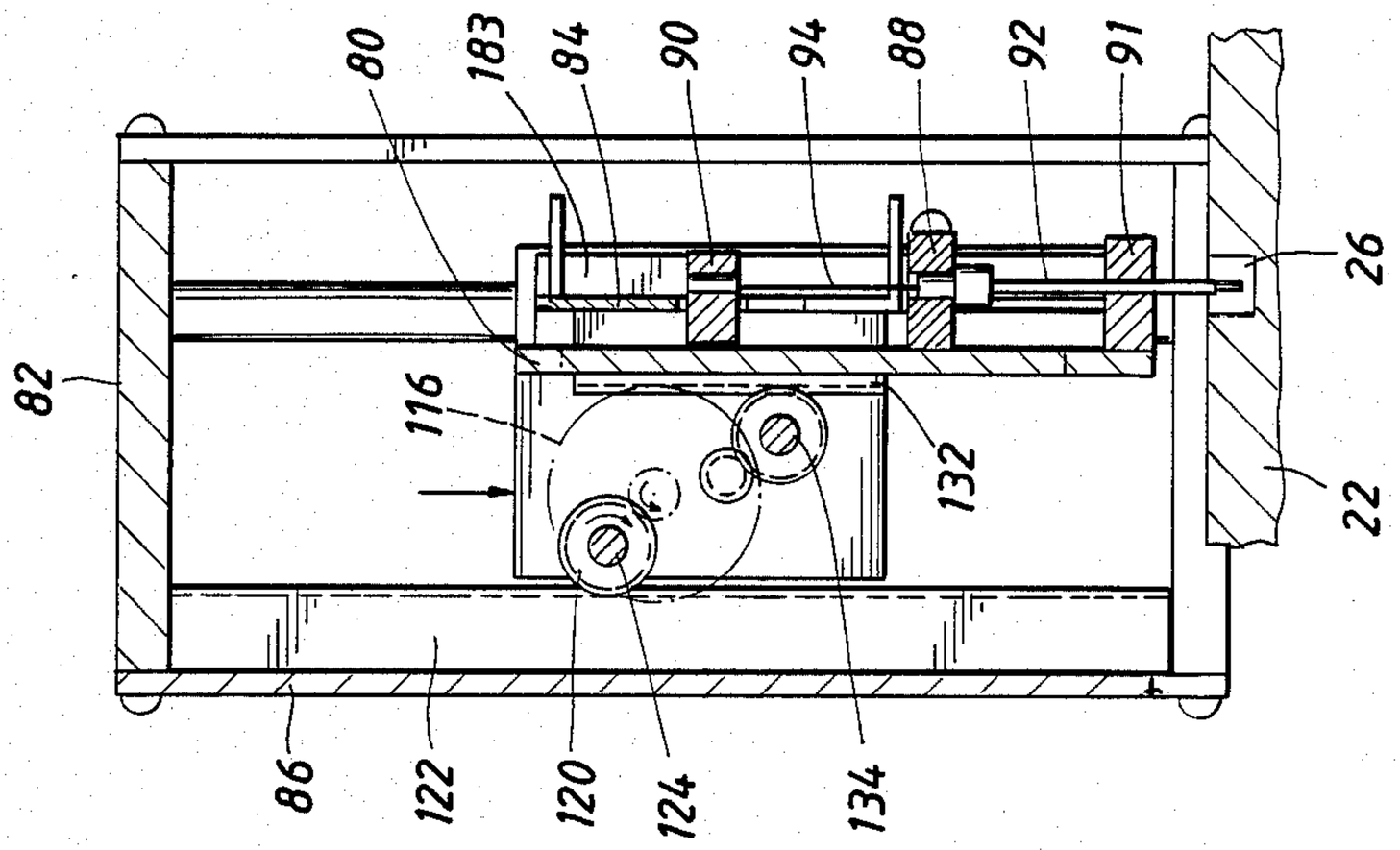

FIG. 12

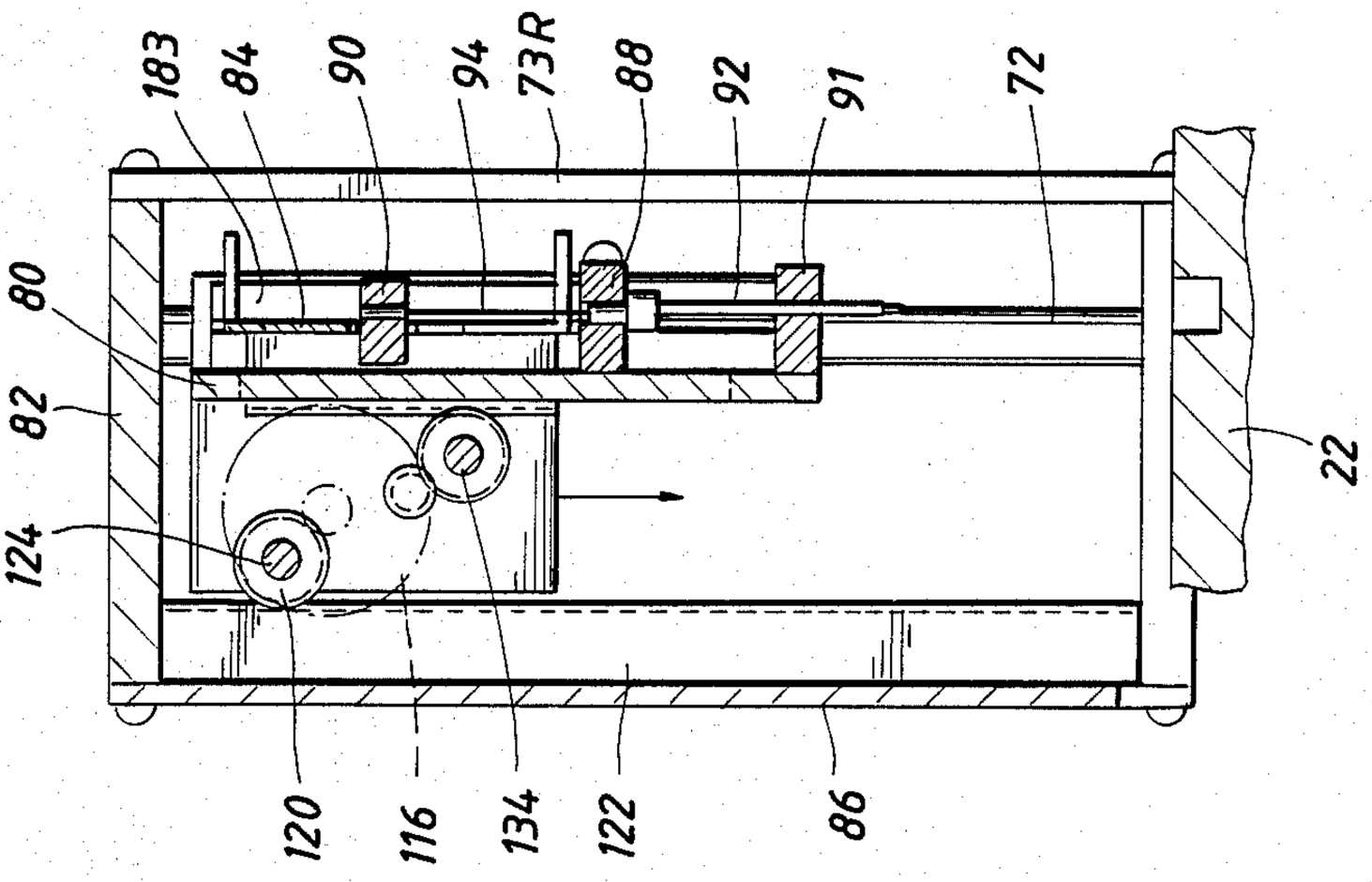

FIG. 9

FIG. 11

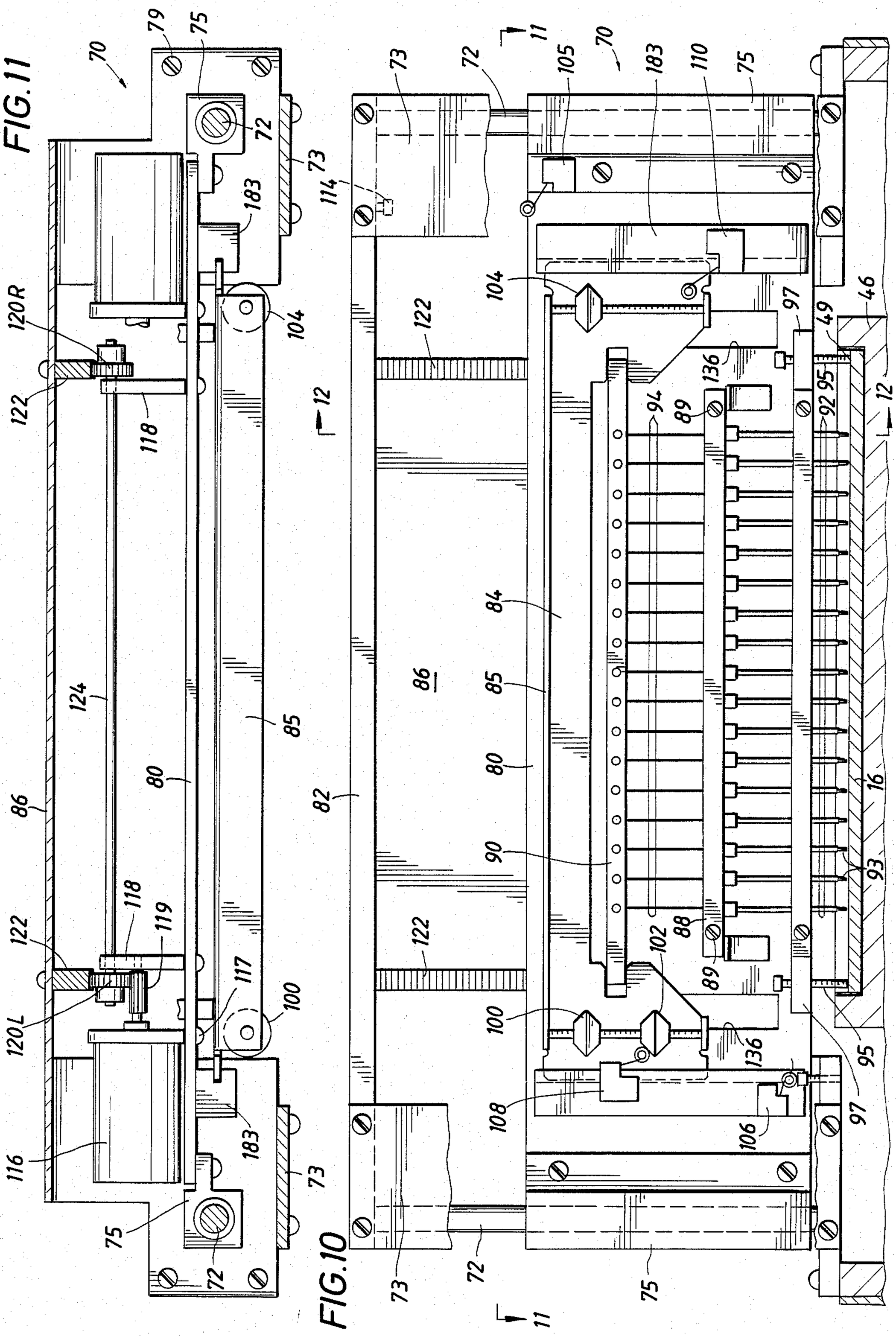
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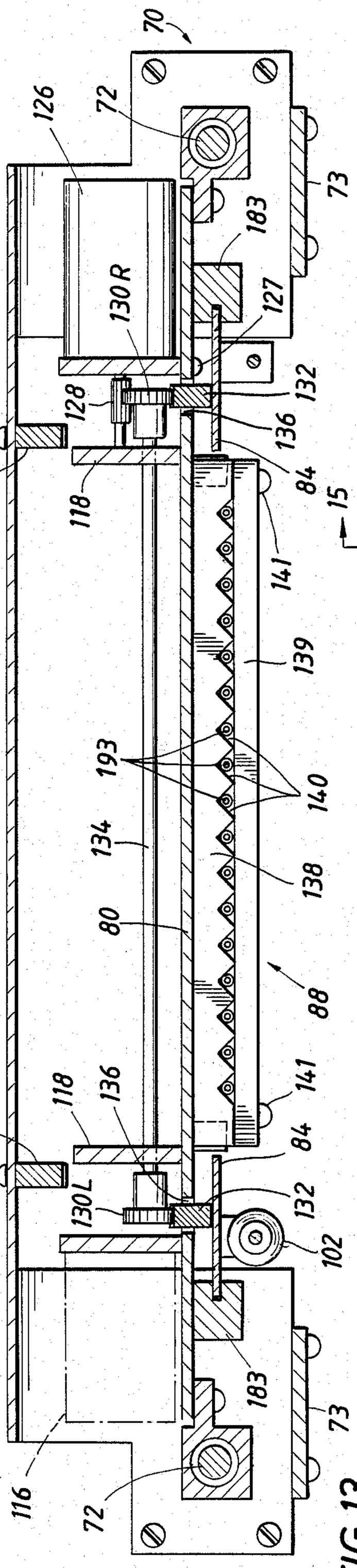
FIG. 10

FIG. 14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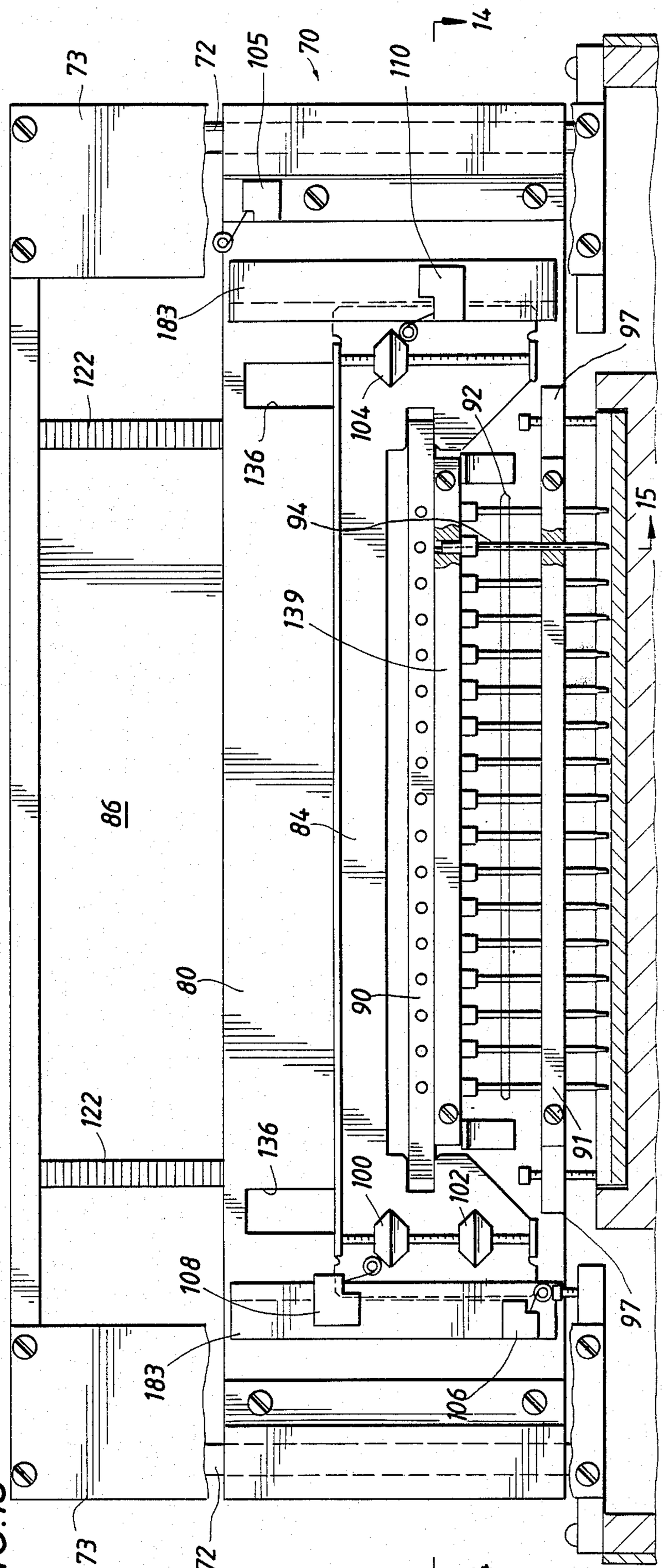
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FIG. 13

FIG. 16

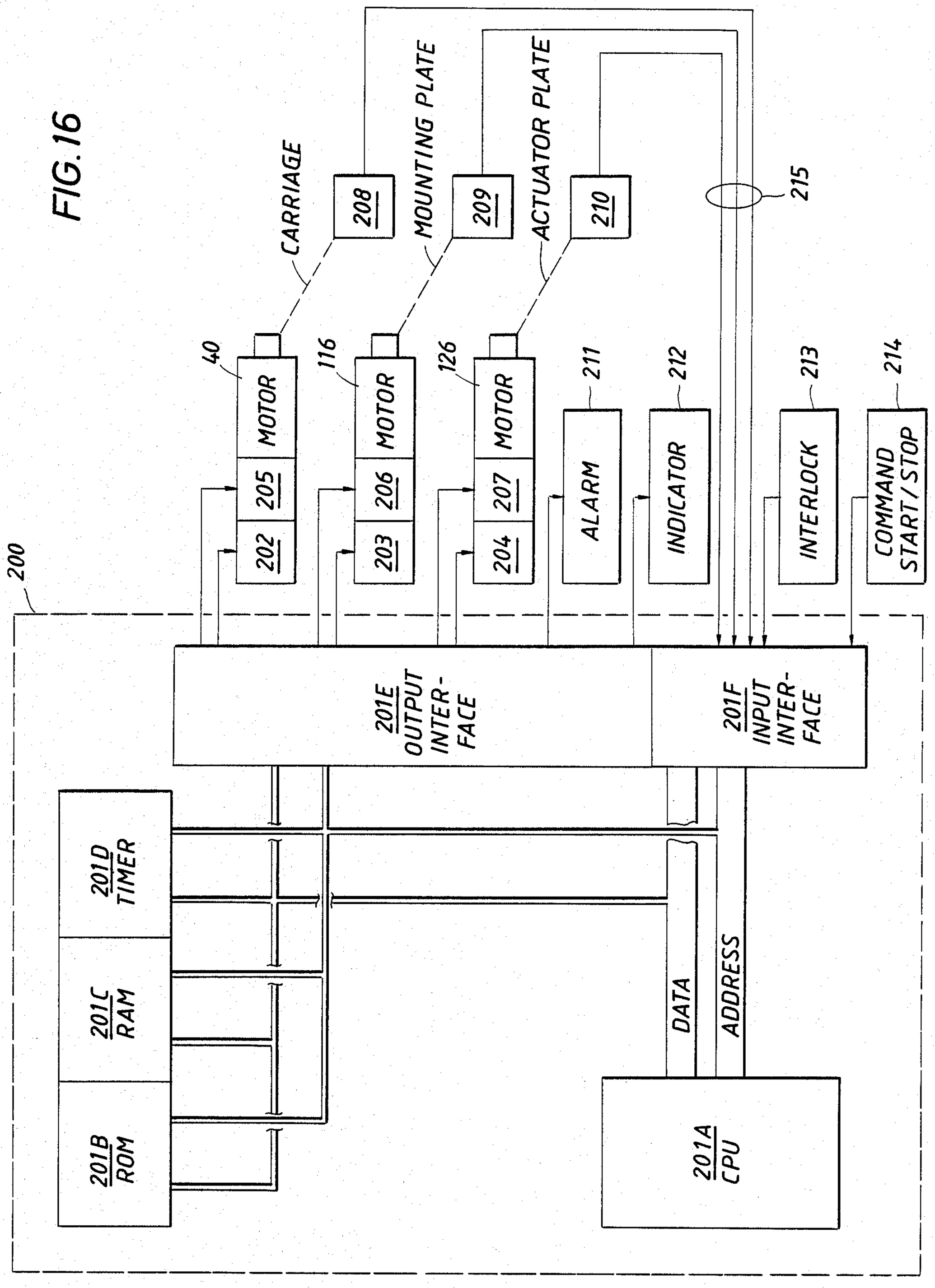
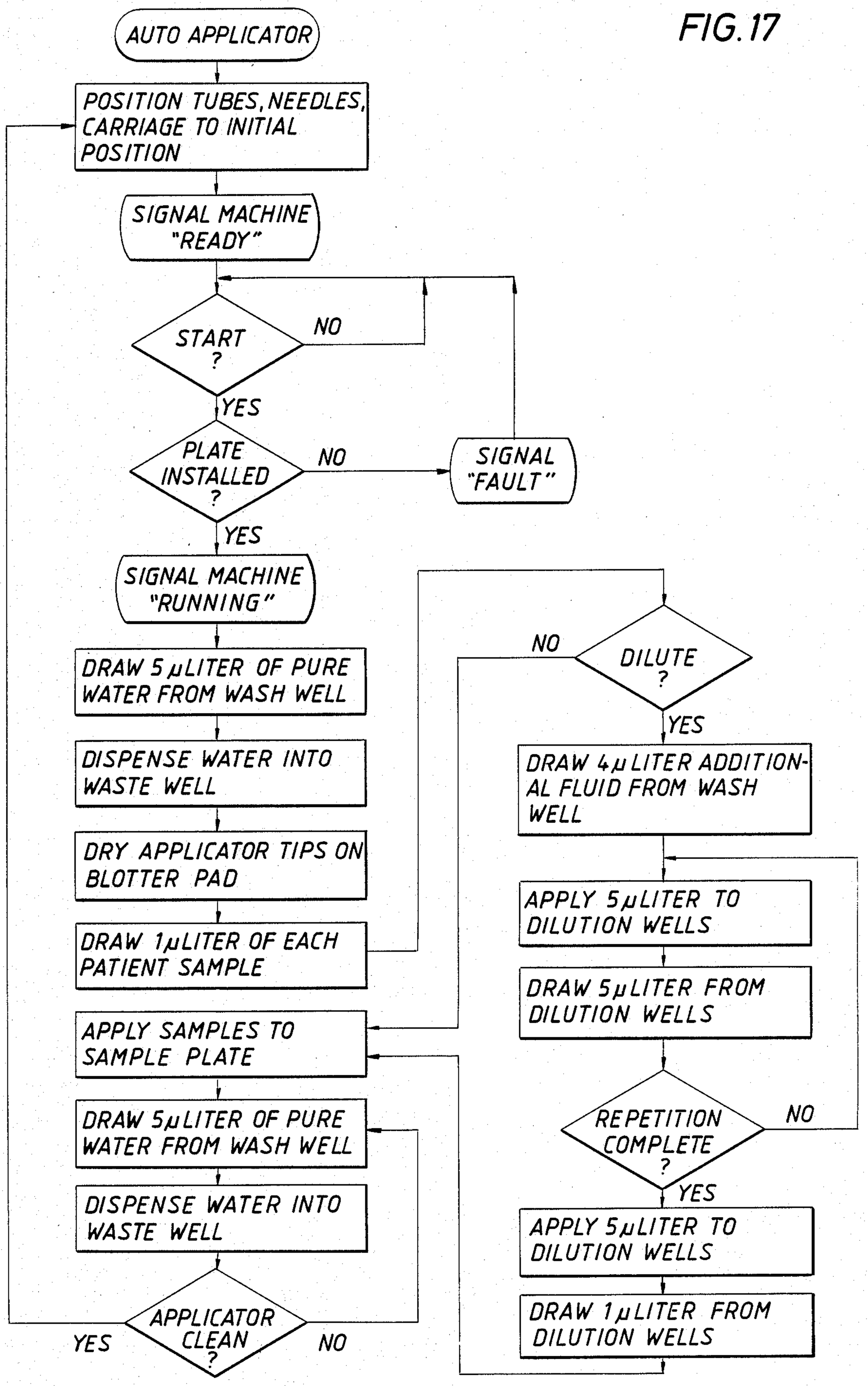

CARRIAGE
MOUNTING PLATE
ACTUATOR PLATE
208
209
210
215
40
116
126
MOTOR
202
205
203
206
204
207
ALARM
211
INDICATOR
212
INTERLOCK
213
COMMAND START/STOP
214
200
201E OUTPUT INTER-FACE
201F INPUT INTER-FACE
201D TIMER
201C RAM
201B ROM
DATA
ADDRESS
201A CPU

FIG. 17


AUTO APPLICATOR
POSITION TUBES, NEEDLES, CARRIAGE TO INITIAL POSITION
SIGNAL MACHINE "READY"
START ?
NO
YES
PLATE INSTALLED ?
NO
SIGNAL "FAULT"
YES
SIGNAL MACHINE "RUNNING"
DRAW 5 µLITER OF PURE WATER FROM WASH WELL
DISPENSE WATER INTO WASTE WELL
DRY APPLICATOR TIPS ON BLOTTER PAD
DRAW 1µLITER OF EACH PATIENT SAMPLE
APPLY SAMPLES TO SAMPLE PLATE
DRAW 5µLITER OF PURE WATER FROM WASH WELL
DISPENSE WATER INTO WASTE WELL
APPLICATOR CLEAN ?
YES
NO
DILUTE ?
NO
YES
DRAW 4µLITER ADDITIONAL FLUID FROM WASH WELL
APPLY 5µLITER TO DILUTION WELLS
DRAW 5µLITER FROM DILUTION WELLS
REPETITION COMPLETE ?
NO
YES
APPLY 5µLITER TO DILUTION WELLS
DRAW 1µLITER FROM DILUTION WELLS

AUTOMATIC PIPETTING APPARATUS

This application is a continuation of application Ser. No. 853,201, filed Apr. 17, 1986, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention is related in general to the field of applying fluid samples to analysis strips. In particular, this invention relates to an automatic pipetting apparatus for applying multiple fluid samples to a microporous support medium such as a cellulose acetate or agarose strip which may be used in the field of zone electrophoresis and with other separation techniques including the field of thin layer chromatography. Zone electrophoresis is the science of moving charged particles in an electric field through a solid or semi-solid medium. The technique is most commonly used in medical research and medical laboratories for analyzing various blood proteins.

2. Description of the Prior Art

In the electrophoresis technique, a blood or other fluid sample is applied to a support medium which is then subjected to an electric field so as to separate the components of the sample. The support media used in the electrophoresis process includes cellulose acetate, agar, agarose and acrylamide gels. In laboratory work it is desirable that a plurality of samples be applied to the support medium such that each of the samples may be subjected to the electric field at the same time.

The samples may be applied to the support medium one at a time in serial fashion with a hand pipetter, but the hand pipetter must be rinsed with a cleansing agent and blotted before a new sample is aspirated and then applied to the strip.

Applicators have been designed to apply fluid samples simultaneously or in "parallel" to the strips. Such applicators are described at page 61 of the General Products Catalog for 1984–1985 of Helena Laboratories with offices in Beaumont, Tex. Such applicators may apply eight, twelve or more samples to a microporous support medium and have the advantage of making the electrophoresis technique easier and more reproducible.

The applicators known prior to this invention however have been essentially non-automatic applicators and required cleaning of the applicator tips after each application to the support medium.

Automatic dispensing systems are known in the prior art. For example, a system sold under the trademark "Well Washers" of BioTech Instruments, Inc. of Burlington, Vt. provides an alignment mechanism by which a row of eight or twelve barrels may be positioned above one of a plurality of rows of washing vials or wells. Automation in the system provides selection of dispensing fill volumes, soaking times and number of wash cycles.

None of the prior art however has provided an apparatus for automatically filling a plurality of pipetters from a respective plurality of fluid chambers and then precisely applying such fluid samples from each pipette to a support medium. Another disadvantage of the prior art systems is that there has been no means for automatically washing and cleaning the barrels during each cycle time so as to prevent contamination of each of the barrels during application of a new plurality of fluid samples to a new support medium.

Another disadvantage of the prior art is that there has been no means for precisely automatically applying a very small amount—of the order of one micro liter of sample liquid—to a support medium.

Another disadvantage of the priot art is that there has been no means for precisely automatically diluting a very small amount—of the order of one micro liter—of sample fluid with a diluting liquid, and precisely applying a very small amount of the diluted sample to a support medium.

IDENTIFICATION OF OBJECTS OF THE INVENTION

It is therefore a primary object of the invention to provide an automatic pipetter apparatus for aspirating from a plurality of sample chamber wells into a corresponding plurality of pipetters and then applying such samples precisely to a microporous support medium to be used in electrophoresis or thin layer chromatography.

It is a further object of the invention to provide an automatic pipetting apparatus which not only aspirates and dispenses sample fluids onto a support medium strip such as cellulose acetate or agarose, but also flushes, cleanses, rinses and blots the tips of the barrels with an appropriate cleaning fluid before and after each application of the sample fluid to the support medium.

It is another object of the invention to provide an automatic pipetting apparatus by which positive displacement pipette barrels and plungers are controlled to precisely apply a very small sample of fluid to a support medium.

It is another object of the invention to provide automatic pipetting apparatus for precisely automatically diluting a very small amount of sample fluid with a diluting liquid and precisely applying a very small amount of the diluted sample to the support medium.

SUMMARY OF THE INVENTION

The objects identified above as well as other advantages and features of the invention are provided in an automatic pipetting apparatus which generally includes a base and a sample plate disposed on the base and a pipette frame including a vertical support for supporting the frame from the base above the sample plate. The sample plate includes a row of individual liquid sample chambers and a lateral application space longitudinally separated from the liquid chamber row. The lateral application space is adapted to receive a microporous support medium. A mounting plate is carried by the pipette frame.

The apparatus includes translation means for effecting relative longitudinal movement of the pipette frame and sample plate, and vertical translation means for effecting relative vertical movement of the mounting plate and the sample plate.

A plurality of microsyringe barrels are removably secured to the mounting plate. The barrels are spaced corresponding to the spacing of the liquid chambers of the sample plate. A plurality of micro-plungers are provided, one each movably disposed in one of the barrels. A plunger translation means is provided for moving the plunger vertically within the barrels.

Signalling means are provided for generating longitudinal signals representative of the relative longitudinal orientation of the pipette frame with respect to the sample plate, for generating mounting plate signals representative of the vertical orientation of the mounting

plate relative to the sample plate and for generating plunger signals representative of the orientation of the plungers relative to the barrels.

A programmed digital computer is provided responsive to the longitudinal signals, the mounting plate signals and to the plunger signals for generating a sequence of control signals to the longitudinal translation means, to the vertical translation means and to the plunger translation means to aspirate a predetermined amount of liquid from the sample chambers into the respective pipette barrels, and to apply the liquid samples in the barrels onto corresponding spaces or "spots" on the microporous support medium when placed on the lateral application space of the sample plate.

One embodiment of the invention includes a base having a track disposed longitudinally on it. A carriage is longitudinally movably disposed on the track [means] and carries a sample plate which is removably disposed on the carriage. The carriage plate includes a lateral row of individual liquid sample chambers and a lateral application space which is longitudinally separated from the liquid chamber row. The lateral application space is adapted to receive a microporous support medium such as a cellulose acetate or agarose strip used in electrophoresis or thin layer chromatography.

A pipette assembly is mounted vertically on the base above the carriage and the sample plate. The pipette assembly includes vertical mounting posts separated laterally from each other and secured to the base. A mounting plate assembly is slidably guided by the posts and is disposed laterally with respect to the sample plate.

The mounting plate assembly includes a mounting plate having slidable guides disposed about the posts. A pipette bar is fixed to the mounting plate. A plurality of microsyringe barrels are provided in a row on the pipette bar with their heads secured thereto. The microsyringe barrels are spaced corresponding to the spacing of the liquid chambers on the plate. The barrels are hollow, each barrel having a lower tip.

A plunger bar is vertically movably disposed above the tip bar and has a plurality of micro-plungers secured thereto. Each of the micro-plungers are movably disposed within a corresponding barrel of the microsyringes. A plunger actuator plate carried by the mounting plate is vertically movable with respect to the mounting plate. The actuator plate is removably secured to the plunger bar.

Translation and signalling means are provided for moving the carriage longitudinally forward and backward beneath the mounting plate assembly and generating carriage position signals indicative of the carriage position. A translation and signalling means is provided for moving the mounting plate assembly up and down with respect to the base and generating mounting plate position signals indicative of the mounting plate position. A translation and signalling means for moving the plunger bar up and down with respect to the mounting plate and generating plunger bar position signals indicative of the plunger bar position is provided.

A programmed microcomputer is provided responsive to the carriage position signals, to the mounting plate position signals, and to the plunger bar position signals for generating a sequence of control signals to the translation means for moving the carriage, the translation means for moving the mounting plate, and the translation means for moving the plunger bar so as to aspirate a first predetermined amount of liquid from the sample chamber into the respective pipette barrels and then to apply the liquid in each of the pipette barrels onto corresponding spaces of the support medium when placed on the lateral application space of the sample plate.

The sample plate includes a wash well and waste well longitudinally spaced form each other and from the sample chamber. The programmed computer generates a further sequence of control signals to the translation means before aspirating liquid from the sample chambers to draw a second predetermined amount of rinse liquid from the wash well into the respective pipette barrels and then to discharge that rinse liquid into the waste well.

The apparatus further provides the sample plate with a longitudinal blotting space for applying a lateral blotting paper strip where the blotting space is longitudinally separated from the sample chamber row, the wash well, the waste well and the lateral application space. The programmed computer generates a further sequence of control signals to the translation means after discharging the wash liquid into the waste well so as to blot the lower tips of the barrel on the blotting paper strip.

Preferably, the sample plate includes a raised portion and a lower portion where the row of individual liquid sample chambers and the wash well and the waste well are disposed on the raised portion and the lateral application space and the blotting space are disposed on the lower portion.

The sample plate may include a row of liquid dilution wells longitudinally spaced from the sample chambers. The programmed computer includes a program, actuated by a dilution signal, for automatically controlling the apparatus for diluting the samples aspirated to the microsyringe barrels with dilution fluid and mixing the sample and dilution fluid in each of the dilution wells before mixed diluted sample fluid is applied to the spots of the support medium.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, advantages and features of the invention will become more apparent by reference to the drawings which are appended hereto and wherein like numerals indicate like parts and wherein an illustrative embodiment of the invention is shown, of which:

FIG. **1** shows a perspective view of one embodiment of the automatic pipetting apparatus of the invention with a sample plate secured thereto and its cover attached;

FIG. **2** is a schematic illustration of the invention showing the functional relationship between the sample plate with its sample chambers, wash well, waste well and a longitudinal application space with a microporous support medium secured thereto beneath a pipette assembly in which individual pipette barrels are moved as a unit up and down and a plunger bar secured to plungers which are moved up and down with respect to the barrels;

FIG. **2A** schematically shows another embodiment of the invention where the mounting plate includes two stationary units and the pipette frame is longitudinally movable with respect to the plate;

FIG. **2B** is a perspective view of another embodiment of the sample plate further including a row of dilution wells;

FIG. 3 is a side view partially cut away and in section with the cover removed and taken from the view along lines 3—3 of FIG. 1;

FIG. 4 is a cross-section of the carriage and the sample plate;

FIG. 5 is a downward looking view along lines 5—5 of FIG. 1 and shows the cross-section of the base at level 5—5 and the track, carriage and sample plates beneath the pipetting assembly;

FIG. 6 is a cross-sectional view taken along lines 6—6 of FIG. 5 and shows the base, the carriage and sample plate according to the invention and further shows the translation and guiding means by which the track is moved forward and backward with respect to the pipetting assembly;

FIG. 7 is a forward looking view taken along lines 7—7 of FIG. 3 and shows partially broken away, partially cross-sectional parts of the pipette assembly slidably mounted on posts secured to the base and including a mounting plate which moves up and down with respect to the base and carrying a row of barrels of individual pipettes and an actuator plate movable vertically with respect to the mounting plate for moving a plunger bar vertically for moving individual plungers within the barrels of each of the pipettes;

FIG. 8 shows a top view of the pipette assembly showing in dashed lines the mounting plate of the pipette assembly;

FIG. 9 shows a cross-sectional view taken along lines 9—9 of FIG. 7 and illustrates the relationship between the mounting plate, the tip bar and the plunger bar and the means by which the mounting plate is moved up and down with respect to the base;

FIG. 10 is a similar view to that of FIG. 7 but shows the mounting plate having been translated to a lower position but with the plunger bar remaining in an upward position whereby the tips of the pipetters are in a downward position, but the plungers are extended upwardly from each of the barrels of the pipettes;

FIG. 11 is a top cross-sectional view taken along lines 11—11 of FIG. 10 and illustrates the motor and rack and pinion system by which the mounting plate is moved up and down with respect to the base;

FIG. 12 is a cross-sectional view taken along lines 12—12 of FIG. 10 and illustrates the relationship of the mounting bar after it has been moved downwardly by the rack and pinion system by operation of the motor turning with respect to the frame mounted rack;

FIG. 13 is a view similar to that of FIGS. 7 and 10 but illustrates the plunger actuator plate and plunger bar moved downwardly with respect to the mounting plate thereby forcing the plungers associated with each of the pipetters into their barrels and forcing any fluid previously aspirated into the barrels out the tips of the barrels;

FIG. 14 shows a cross-sectional view taken along lines 14—14 of FIG. 13 and illustrates the rack and pinion system by which the actuator plate and the plunger bar secured thereto is moved up and down with respect to the mounting plate;

FIG. 15 is a cross-sectional view taken along lines 15—15 of FIG. 13 and illustrates the movement of the actuator plate downwardly with respect to the mounting plate by operation of the rack and pinion system controlling relative movement between the actuator plate and the mounting plate;

FIG. 16 is a schematic illustration of the microcomputer integrated circuit device receiving signals from position detector circuits associated with the carriage, the mounting plate and actuator plate and applying translation signals to motors for positioning the carriage, the mounting plate and the plunger actuator plate; and

FIG. 17 is a functional flow chart illustrating the stored program in the microcomputer device for automatically washing, blotting, sampling and applying samples to the support medium strip.

DESCRIPTION OF THE INVENTION

FIG. 1 illustrates in a perspective view the automatic pipetting apparatus 10 according to the invention. The apparatus includes a base 12 on which a sample plate 16 is movably supported. The sample plate includes a space 21 for securing a microporous support medium 20 such as a cellulose acetate or agarose strip used in the field of zone electrophoresis or other separation techniques including the field of thin layer chromatography. A cover 14 is provided behind which a pipette head 18 is shown.

FIG. 2 is a schematic illustration of the essential mechanical elements of one embodiment of the invention with the base and the cover removed. None of the mounting apparatus is shown in FIG. 2 so as to simplify the explanation of the relationship of the sample plate 16 to the pipette assembly 70. The translational means are shown in a functional way rather than in actual mechanical detail which will be shown in detail in the figures and discussion below.

The sample plate 16 as shown includes a row of sample chambers 24 as well as a wash well 26, rinse or "waste" well 28 and a longitudinal space 21 on which a microporous support medium 20 is removably secured. The sample chambers 24, the rinse well 28 and the wash well 26 are provided on raised portions 22 of the sample plate. If desired, a plastic cup may be provided in each of sample chambers 24. A blotter space 32 between the rinse well 28 and the sample chambers 24 is provided at substantially the same vertical level 49 as the sample application space 21 on which the support medium 20 is secured.

As illustrated in FIG. 2, the various regions of the sample plate are longitudinally distinct, yet the lateral spacings between the sample chambers 24 corresponds to the application spots 19 on the support medium 20 which is indicative of the fact that the barrels 92 of the pipette assembly 70 are arranged in a row corresponding to the sample chambers 24. Liquid from those chambers is aspirated by the automatic pipetting apparatus and is applied in a similar row on the spots 19 of the microporous support medium 20.

It is advantageous to provide the sample chambers 24, waste well 28 and wash well 26 in raised portions 22 of the sample plate 16 so that the mounting plate 80 of the pipette assembly 70 need only go down to a common downward position during all wash, waste, blot, sampling and application operations. However, it would be obvious to one of ordinary skill in the art that other arrangements could be provided especially where different levels of the mounting plate could be provided in the translation and signalling apparatus for controlling the mounting plate 80. A detailed discussion of such translation and signalling apparatus for controlling the mounting plate 80 is discussed below.

The schematic illustration of FIG. 2 shows that the sample plate 16 is translated in forward and rearward directions beneath the pipette assembly 70 by virtue of

the motor **40** turning a pinion **38** having its gears in engagement with those of rack **36**. As the shaft of the motor **40** turns, the sample plate **16** carried by the rack **36** moves back and forth beneath the pipette assembly **70**.

Turning now to the pipette assembly **70** shown in FIG. **2**, a mounting plate **80** is translated upwardly and downwardly by means of mounting plate motor **116** having its pinion **120** engaging a rack **122**. Thus, the entire mounting plate **80**, and the microsyringe barrels **92** attached to the barrel bar **88** which is secured to the mounting plate **80**, moves up and down in accordance with the turning of the mounting plate motor **116**. Similarly, the plungers **94** which are attached to plunger bar **90** and actuator plate **84** are moved up and down with respect to mounting plate **80** by operation of the turning of actuating plate motor **126** and its pinion **130** engaging actuator rack **132**. For purposes of illustration, the actuator plate motor **126**, its pinion **130** and the actuator plate rack **132** are shown on the forward side of mounting plate **80**, but the actual apparatus illustrated in the subsequent figures is to the rearward side of the mounting plate **80** through slots in it.

FIG. **2** therefore shows all of the essential elements as far as the translation of the sample plate **16** backward and forward beneath the microsyringe barrels **92** and illustrates the upward and downward translation means of the mounting plate **80** and the microsyringe barrels **92**, and the upward and downward motion of the plungers **94** and the plunger bar **90** and actuator plate **84** with respect to the mounting plate **80**.

FIG. **2A** schematically illustrates an alternative embodiment of the invention where the sample plate remains immovable with respect to the base **12'** with the pipette assembly **70'** being mounted on rollers **300** for longitudinal translation. FIG. **2A** illustrates that the sample plate may include two units, an application plate unit **16A** and a fluid plate unit **16B**. The sample plate unit **16A** is adapted to removably secure a support medium **20'**, while the fluid plate unit **16B** includes a row of sample chambers **24'**, a waste well **28'**, a wash well **26'** and a blotting space **32'**. The operation of the alternative embodiment is similar to that of the embodiment of FIG. **2** except that translation and signalling means are provided for longitudinally translating pipette assembly **70'** with respect to the sample plate(s) **16A, 16B**. Details of such translation and signalling means will be apparent to one of ordinary skill in this art by virtue of the detailed description of analagous translation and signalling means described below.

FIG. **2B** illustrates an alternative sample plate **16'** which may include an additional row of dilution wells **25** in addition to the row of sample chambers **24**, waste well **28**, wash well **26** and blotting space **32**. Explanation of the automatic diluting of sample fluid will be described below with reference to FIG. **2B**.

FIG. **3** is a side view taken along lines **3—3** of FIG. **1** with a portion of track **34** cut away to show its construction. The tracks **34** are supported by track supports **48** which may also be seen in FIG. **5**. The pipette assembly **70** is vertically supported from base mounting block **78** which is secured to the sides of the base **12** and is also further illustrated in FIG. **5**. The pipette assembly **70** includes a back plate **86** and a front plate **73**. One of the plurality of barrels **92** of the pipette assembly is shown in an upward position.

A carriage **46** is slidably movably disposed on track **34** as more clearly seen in FIG. **6**. Racks **36** are secured to carriage **46** and are movable with respect to the base **12** by means of the carriage motor **40** having its pinion **38** in engagement with rack gear **36**.

Notches are provided along the left edge of the carriage **46**. These notches cooperate with a trip switch to provide signals indicative of the longitudinal position of the carriage. The wash notch **50**, rinse notch **52**, blot notch **54**, sample chamber notch **56**, dilution chamber notch **57** (where the alternative sample plate **16'** of FIG. **2B** is used) and application notch **58** are illustrated in FIG. **3**.

FIG. **4** illustrates a vertical cross-section through the carriage **46** and the plate **16** and shows the actual wash well **26**, rinse well **28** and one of the sample chambers **24** on raised portion **22** of the plate **16**. A blotter space **32** and a lateral application space **21** are illustrated on plate **16**. Blotter paper **30** is shown in blotter space **32** while a microporous support medium **20** such as cellulose acetate or agarose is secured in lateral application space **21**.

FIG. **5** is a downward view taken along lines **5—5** of FIG. **1**. Carriage **46** is shown supported by tracks **34** and movable in the rearward and forward directions by means of motor **40**, pinion **38** and rack **36** as also illustrated in FIG. **6**. The sample plate **16** is disposed in a valley or U-shaped cross-sectional structure **47** of carriage **46**.

Position signalling notches on the sides of the carriage **46** cooperate with trip switch **60** and trip switch **62** fixed to tracks **34**. Spring loaded rollers **61** and **63**, respectively are forced against the longitudinal edges of carriage **46** and into the notches as the carriage **46** moves past them. For example, the notches on the left hand side **46** include the wash notch **50**, the waste notch **52**, the blot notch **54**, the sample chamber notch **56** and an application notch **58**. The notches correspond to the longitudinal position of the wash well **26**, waste well **28**, blotter paper **30**, sample chambers **24** and application spots **19** when those wells, chambers and blotting and application spots are directly beneath the pipette barrels **92**.

When the carriage **46** moves rearwardly where the wash well **26** is directly beneath the barrels **92**, the roller **61** moves into the wash notch **50** thereby tripping the trip switch **60** for signalling the microprocessor associated with electronic module **200** (FIGS. **3** and **16**) that the wash well is beneath the barrels **92**. The trip switch **60** is likewise tripped when the roller **61** enters notches **52**, **54**, **56** and **58** to signal the position of the respective other wells, chambers and spots beneath the barrels **92**.

On the right hand side of the carriage **46** is notch **59** in which the roller **63** is shown. A sample plate trip swtich **62** is thereby tripped to indicate that the carriage is at its maximum forward position. Trip switch **65** is mounted on the rear edge of carriage **46**. Switch **65** closes when the rear edge of the plate **16** is in position and engages it thereby generating a signal that the plate **16** is properly in position on carriage **46**. The stops **64** provide means for accurately longitudinally positioning application spots **19** beneath barrels **92** when carriage **46** is in the maximum rearward position.

Also shown in FIG. **5** is a start button **214** by which the programmed microprocessor is signalled to start the automatic sequence of events for the automatic pipetting apparatus which will be explained in detail below. Lamp **212** provides a visual indication to the user of the

automatic pipetting apparatus **10** that the power is turned on.

FIG. **6** illustrates in a cross-sectional view taken along lines **6—6** of FIG. **5** the means by which the carriage is translated with respect to tracks **34**. The tracks **34** are supported upon base **12** by means of supports **48**. The carriage **46** includes slots **149** in its sides on which it slides on tracks **34**.

Plate **16** as indicated above is disposed within a notch or valley **47** of the carriage **46**. The carriage translation motor **40** is fixed to the base **12** and includes a shaft **42** which is supported by means of shaft supports **44**. Pinions **38** secured to shaft **42** have their gears in engagement with racks **36** which are attached to the carriage **46**. As the motor **40** is turned in one direction or the other under control of the microprocessor in the electronic module **200** (FIG. **16**), the carriage **46** moves in the forward or rearward directions.

FIG. **7** illustrates the pipette assembly **70** looking rearwardly along lines **7—7** of FIG. **3**. The mounting blocks **76** are shown secured to the base mounting blocks **78** by means of screws **79**. The mounting blocks **76** carry vertical mounting posts **72** as illustrated in FIGS. **7**, **10** and **13** and in the top views of FIGS. **8**, **11** and **14**. The front plates **73** and back plate **86** are secured by means of screws to mounting blocks **76**.

A mounting plate **80** is vertically slidably supported about the vertical mounting posts **72**. Retainer bearings **74** provide sliding engagement between the posts **72** and vertical bearing blocks **75**. The mounting plate **80** is fastened to extensions of bearing blocks **75** by means of screws **81**. By reference to FIGS. **7** and **13**, it is seen that mounting plate **80** may be moved from its upward position as shown in FIG. **7** to its lower position as shown in FIG. **13** by its attachment to bearing blocks **75** and their sliding engagement on posts **72**.

A barrel bar **88** is secured to mounting plate **80** by means of screws **89**. Mounted on barrel bar **88** are a plurality of pipette barrels **92** having their heads **193** secured within the barrel bar **88** in a manner to be described below. As illustrated in the partial cut away of barrel bar **88**, the barrel lock bar **91** secures the lower portions of the barrels **92** to provide stability to the barrels. Guide tips **97** include adjustable screws **95** extending below the bottom edge of the mounting plate **80** which cooperate with the lower surfaces **49** of plate **16** to accurately vertically position the lower tips **93** of barrels **92** with respect to the support medium **20** and blotting paper **30** disposed on lower surface **49** of plate **16**. Such adjustment allows the droplets which form on the ends of the tips **93**, when plungers **94** are driven downwardly within barrels **92**, to "kiss" or be slightly applied either to the support medium or the blotting paper. The droplets on the lower tips **93** of the barrels **92** are held because of their small size (as small as one micro liter) and surface tension forces of the barrel tips. When the tips are brought to a small distance within the upper surface of the support medium **20** or blotting paper **30**, the droplets are relieved of the surface tension holding them to their barrels and are precisely applied to the blotting paper or to the support medium.

Acutator guides **183** are secured to the mounting plate **80** and include grooves in which an actuator plate **84** is inserted for sliding movement upwardly and downwardly with respect to the mounting plate **80**. The actuator plate **84** has grooves in which a plunger bar **90** is inserted. The plungers **94** of the microsyringe barrels **92** are secured to the plunger bar **90** and extend within the barrels **92**. As illustrated in FIG. **7**, the plungers **94** are at their uppermost extent with respect to the barrels **92**. The actuator plate **84** is adapted to move downwardly with respect to the mounting plate **80**, and through such action, the plunger bar **90** moves downwardly with respect to the barrel bar **88** causing plungers **94** to move downwardly within the barrels **92** thereby forcing any fluid within such barrels outwardly through the tips **93** of the barrels and forming a droplet at the tips of the barrels.

Position signals are generated indicative of the position of the mounting plate **80** with respect to the base **12** and the position of the actuator plate **84** and its plungers **94** with respect to the mounting plate **80**. The trip switch **106** mounted on the mounting plate **80** cooperates with the lower stop **115** mounted on the mounting block **76** to provide a lower mounting plate position signal when the mounting plate **80** reaches its lower extent. In a similar way as shown on the right hand side of the mounting plate **80**, the upper trip switch **105** is mounted on the mounting plate **80** and is shown tripped by contact with the upper stop **114**. The upper trip switch **105** when tripped provides a signal to the microprocessor of electronics module **200** (FIG. **3**) indicative that the mounting plate **80** is in its upper position.

The trip switch **108** mounted on left hand side actuator **183** cooperates with application position cam **100** and wash cam **102**. The trip switch **108** is tripped by the application cam **100** when the actuator plate **84** moves upwardly with respect to the mounting plate **80** and the trip switch **108** is tripped by wash cam **102** as the actuator plate **84** moves further upwardly. The down cam **104** trips trip switch **110** mounted on the right hand side actuator guide **183** when the actuator plate **84** reaches its maximum downward travel where the plungers **94** are within the barrels **92**.

FIG. **9** is a cross-sectional view taken along lines **9—9** of FIG. **7** and illustrates the mounting plate **80** and the actuator plate **84** both in their upward positions. Mounting plate motor **116** has driven the mounting plate **80** to the upward position by operation of pinion **120** on rack **122** which is secured to the back plate **86** and to the base of the apparatus.

Turning now to FIG. **10**, the pipette assembly **70** is shown with the mounting plate **80** in the downward position but the plunger bar **90** and the plungers **94** are in their upward position with respect to the barrel bar **88**. The barrels **92** are in a downward position in the wash well for aspirating 5 μl fluid, for example, from the wash well **26**.

FIG. **11**, a view of the pipette assembly looking downwardly along lines **11—11** from FIG. **10**, illustrates the drive mechanism by which the mounting plate **80** is moved up and down with respect to the base. A mounting plate actuator motor **116** is fixed to the mounting plate **80** by means of a mounting screw **117**. The output shaft of the motor **116** has a gear **119** fixed to it. Gear **119** is engaged with a left pinion gear **120L** which is mechanically coupled to a right pinion gear **120R** by means of shaft **124**. The shaft is mounted to the mounting plate **80** by shaft mountings **118**. Racks **122**, fixed to the back plate **86**, have their gears in engagement with pinion gears **120L** and **120R**. As the motor **116** turns in either direction under microprocessor control, the mounting plate **80** is moved upwardly or downwardly with respect to the base and the back plate **86** by the rack and pinion mechanism. The front view (FIG. **10**) of the pipette assembly **70** with the mounting plate

80 in a downward position shows the racks 122 visible. The front view also illustrates, with the mounting plate 80 in its maximum downward position, that stop screws 95 of guide tips 97 are slightly above surfaces 49 of the plate 16 indicative that tips 93 are slightly above the top edge 49 of the plate so that droplets which form on the tips may "kiss" the surface 49 and apply sample fluid to the support medium or blotting paper.

FIG. 12 is a cross-sectional view of the pipette apparatus taken along lines 12—12 of FIG. 10 and shows that the mounting plate actuator motor 116 has turned its pinion gear 120 so that the mounting plate 80 has been moved downwardly with respect to the base and the raised portion 22 of the plate 16. Thus, the barrel 92 has been lowered to be within a well of the raised portion 22 of the sample plate. A wash well 26 is illustrated as an example where the barrels 92 of the pipettes have been lowered by the mounting plate 80 and where the fluid from the wash wells have been aspirated into barrels 92 by virtue of the plungers 94 being pulled upwardly by means of the actuator plate 84. It is apparent from FIGS. 11 and 12 that the mounting plate 80 is translated upwardly and downwardly with respect to the raised portion 22 by means of the motor 116 turning and causing the pinion 120 to translate upwardly and downwardly on fixed rack 122.

Turning now to FIG. 13, the state of the pipette apparatus 70 is such that the actuator plate 84 has moved downwardly causing the plungers 94 to be inserted back into the barrels 92 thereby positively displacing any fluid which has been aspirated within the barrels either to an application space, a blotter, or to a waste well. It is seen that the trip switch 108 has been returned to a condition such that any upward movement of the actuator plate 84 will be tripped first by the application cam 100 and then the wash cam 102 providing a means for signalling the position of the actuator plate 84 with respect to the mounting plate 80.

FIG. 14, is a downward looking view along lines 14—14 of FIG. 13 and illustrates the drive mechanism by which the actuator plate 84 is translated upwardly and downwardly with respect to the mounting plate 80. A plunger bar actuator plate motor 126 is fixed to the mounting plate 80 by means of a mounting screw 127. The motor 126 includes a gear 128 on its output shaft which is in engagement with pinion gear 130R. Pinion gear 130R is coupled to a pinion gear 130L by means of a shaft 134 which is supported by means of shaft mountings 118 which also supports shaft 124 (see FIG. 11). The actuator plate 84 has actuator plate racks 132 fixed to the rear side thereof which extend through slots 136 in the mounting plate so as to engage the pinions 130L and 130R. As the plunger bar actuator plate motor 126 is caused to turn in either the clockwise or the counterclockwise direction, the actuator plate 84 is caused to move upwardly or downwardly with respect to the mounting plate 80. FIG. 13 shows the slots 136 in the mounting plate 80 through which the actuator plate racks 132 extend.

FIG. 14 also shows the means by which the barrel heads 193 of the barrels 92 are removably fixed to the barrel bar 88. The barrel bar 88 comprises a receiving bar 138 having slots 140 provided along its front face. The barrel heads 193 are inserted therein and secured by means of a securing bar 139 which holds the barrels vertically in place. The securing bar 139 is secured to the receiving bar 138 by means of screws 141. The barrel lock bar 91 similarly constructed as the barrel bar 88. The barrel bar 88 provide a removably securing means by which the barrels 92 may be easily replaced due to wear or breakage.

FIG. 15 is a cross-sectional view looking along lines 15—15 of FIG. 13 and illustrates the mounting plate 80 in a downward position. The actuator plate 84 has been translated downwardly where the plunger bar 90 is adjacent the barrel bar 88. FIG. 15 illustrates the actuator plate racks 132 extending through slots of the mounting plate 80 and their engagement with pinion gear 130 which has been turned by means of the actuator plate motor 126. The barrel 92 is now in a rinse well 28, for example. The plunger 94 has been forced down by means of the actuator plate 84 moving the plunger bar 90 to its lowermost position. Of course, the raised portion of the plate 22 has moved longitudinally with respect to the pipette assembly between the views of FIGS. 12 and 15.

FIG. 16 illustrates schematically the means by which the carriage mounting plate and plunger actuator bars are controlled to perform the automatic pipetting operation.

The dotted box 200 represents a microcomputer integrated circuit device, preferably a microcircuit No. HD68P01V07 manufactured by the Hitachi Corporation. The circuit includes a central processing unit 201A, a read only memory 201B, a random access memory 201C, a timer 201C, a timer 201D, an output interface circuit 201E and input interface circit 201F. The read only memory circuit 201B includes stored software by which the entire automatic operation is controlled and will be discussed below.

FIG. 16 illustrates the carriage motor 40, the mounting plate 116 and the actuating plate motor 126 all under computer control via the motor driver circuits 202, 203, 204 such as circuits UDN-2952B manufactured by the Sprague Corporation. These motor driver circuits are used to control the speed of the motor and its direction of rotation. Also provided in conjunction with the motor are electronic break circuits 205, 206, 207 which are provided to quickly break the motor's rotation on receipt of a translation signal by the computer 200. Such electronic motor break circuits are preferably 2N6075 Triac circuits.

The position detector circuits 208 represent the circuitry with the trip switches 60 and 62 illustrated in FIG. 5 which indicate the position of the carriage 46 and the sample plate 16 with respect to the pipette assembly.

The position detector circuits 209 represent the circuitry associated with the lower trip switch 106 and the upper trip switch 105 which signal the upward or downward limits of travel of the mounting plate 80 with respect to the base.

The position detector circuits 210 represent the circuitry associated with trip switches 108 and 110 which indicate the relative position of the actuator plate 84 with respect to the mounting plate 80. The signals associated with each of those position detector circuits are represented as being carried by a bundle of electrical leads 215 to the input interface circuitry 201F of electronic module 200.

The alarm circuit 211 is provided for the apparatus, for example, such as a sounding device EAF14R06C manufactured by Panasonic. Such circuit is activated and a sound is generated to signal faults in the operation of the apparatus or to signal the readiness of the machine.

Indicator circuit **212** represents an indicator lamp as illustrated in FIG. **5** to signal the user that the power is on to the apparatus. The interlock circuit **213** represents the circuitry with sample plate interlock trip switch **65** which indicated the presence or absence of the sample plate on the carriage. Command circuit **214** represents a push button switch used to start or abort the automatic pipetting application process.

In operation, the central processing unit **201A** receives the sequences of events instructions from the programs stored in the read only memory **201B**. The central processing unit **201A** then receives positional information concerning the moving mechanisms of the apparatus by means of reading and decoding the binary coded data present at the input interface **201F** which receives information via leads **215** from the position detector circuits **208, 209, 210.**

The microprocessor CPU **201A** then receives an input command to start or abort the process by means of reading and decoding the binary coded data present at the input interface **201F** which is connected to the command circuit **214** which may be the push button **214** illustrated in FIG. **5.**

FIG. **17** illustrates in flow chart form the operations of the CPU **201A** under program control. The CPU **201A** determines the validity of a command to start the processing by means of reading and decoding the binary coded data present at the input interface **201F** which receives a signal from the interlock circuit **213.** This operation insures that the plate **16** is fully inserted into the carriage.

The CPU **201A** causes the motors **40, 116** or **126** to turn in the required direction by means of writing the appropriate binary coded data to the output interface circuit **201E** which is connected to the motor drive circuits **202, 203** and **204.** The microprocessor CPU **201A** then causes the mechanism movement to stop precisely when the required location is reaches by writing the appropriate binary coded data to the output interface circuit **201E** which is connected to the motor drive circuits **202, 203, 204** to disable the drive and then writing the appropriate binary coded data to the output interface **201E** which is connected to the motor break circuits **205, 206, 207** to apply electronic breaking.

The microprocessor circuit **201A** then signals that the pipetting apparatus is ready or that a plate has been complete or that a failure has occurred by means of writing the appropriate binary coded data to the output interface circuit **201E** connected to the alarm circuit **211** to sound an alarm.

The timer **201D** of FIG. **16** is used by the microprocessor CPU **201A** to determine electrical or mechanical failures of the positioning mechanism. This is accomplished by means of measuring the elapsed time during a command to drive any motor. If the event is not completed within the prescribed length of time, the drive command is aborted and the alarm is activated by means of the microprocessor CPU **201A** writing the appropriate binary coded data to the output interface connected to the alarm circuit **211.** The timer **201D** is also used to determine the repetition rate of the alarm thereby allowing the microprocessor circuit CPU **201A** to encript and communicate to the operator the nature of the failure.

As shown in FIG. **17,** once the automatic pipetting apparatus of the invention is running, a wide variety of different applications may be achieved. The sequence of operations shown in FIG. **17** is preferred in that first, five microliters of cleansing agent such as distilled water is aspirated into the barrels of the pipettes from the wash well. Next, the water in the barrels is dispensed into the waste well. Then the applicator tips are dried by lowering them to a blotter pad as illustrated in FIG. **5.**

Next, the barrels are moved to their upward position with the plungers in their downward position, the carriage is moved rearward and the barrels are lowered into the sample chambers **24.** The plungers are raised thereby drawing a small amount of each sample of liquid, for example, patient blood to be tested. Where no dilution of the blood samples is desired, the samples are applied precisely to the cellulose acetate or agarose strip. The barrels are raised again. Again, the carriage is moved forward until the wash well is beneath the barrels and the mounting plate is lowered such that distilled water is again drawn into the barrels and then dispensed into the waste well.

Where dilution of the sample liquids is desired, the sample plate of FIG. **2B** may be substituted for that of FIG. **2** and the computer program illustrated by the flow chart of FIG. **17** branches to the dilute routine. A preferred routine for diluting the samples is to draw an additional four micro liters of fluid from the wash well. This action results in each of the barrels being filled with four micro liters of diluting fluid (e.g, water) and one micro liter of blood (or other liquid) sample. Next the entire five micro liters of fluid of each barrel is applied to the respective dilution chambers of the dilution row of the plate of FIG. **2B.** This process may be repeated a desired number of times to effect moving of the sample with the dilution fluid (water). Finally a one micro liter sample of the diluted blood sample is drawn into each barrel according to the description presented previously. The routine then proceeds as described above where the one micro liter of diluted liquid sample is applied to the support medium.

The dilution routine described above is preferred, but other routines may be used to effect good mixing of the blood sample with diluting liquid. For example, a first predetermined amount of liquid sample in each barrel may be applied to the dilution wells. A predetermined amount of wash liquid may then be applied to the dilution wells. After mixing the combination of the wash liquid and liquid sample of the dilution wells, (for example by the mixing technique described above), a small amount of liquid samples is aspirated from the dilution wells and applied to the support medium.

The appendix to this specification includes a source listing of the computer program written in HD68P01V07 Hitachi Assembly language which is stored in the read only memory **201B** so as to automatically control the pipetting, cleansing, blotting, diluting (at the operator's option) and other functions described above.

Various modifications and alterations in the described structures will be apparent to those skilled in the art of the foregoing description which does not depart from the spirit of the invention. For this reason, these changes are desired to be included in the appended claims. The appended claims recite the only limitation to the present invention and the descriptive manner which is employed for setting forth the embodiments and is to be interpreted as illustrative and not limitative.

APPENDIX TO SPECIFICATION

```
                        *** INTERNAL REGISTER MAP ***

                        **************************
                        * INPUT/OUTPUT PORTS *
                        **************************

0000                    P1DDR    EQU   $0000     * Port 1 Data Dir. Reg.
0001                    P2DDR    EQU   $0001     * Port 2 Data Dir. Reg.

0002                    PORT1    EQU   $0002     * Port 1 Data Register

                        * Bit0= (P10)  Carriage Tbrake
                        * Bit1= (P11)  Not used
                        * Bit2= (P12)  Tube Tbrake
                        * Bit3= (P13)  Not used
                        * Bit4= (P14)  Needle Tbrake
                        * Bit5= (P15)  Needle Motor enable
                        * Bit6= (P16)  Tube Motor enable
                        * Bit7= (P17)  Carriage Motor enable

0003                    PORT2    EQU   $0003     * Port 2 Data Register

                        * Bit0= (P20)  Not used
                        * Bit1= (P21)  Beeper output
                        * Bit2= (P22)  Not used
                        * Bit3= (P23)  Not used
                        * Bit4= (P24)  Not used

0004                    P3DDR    EQU   $0004     * Port 3 Data Dir. Reg
0005                    P4DDR    EQU   $0005     * Port 4 Data Dir. Reg

0006                    PORT3    EQU   $0006     * Port 3 Data Register

                        * BIT0= (P30)   DIRECTION BIT FOR CRG MOTOR
                        * BIT1= (P31)   DIRECTION BIT FOR CRG MOTOR
                        * BIT2= (P32)   DIRECTION BIT FOR TUBES MOTOR
                        * BIT3= (P33)   DIRECTION BIT FOR TUBES MOTOR
                        * BIT4= (P34)   DIRECTION BIT FOR NEEDLES MOTOR
                        * BIT5= (P35)   DIRECTION BIT FOR NEEDLES MOTOR
                        * BIT6= (P36)   NOT USED
                        * Bit7= (P37)  NOT USED
                        * SC1= Not used
                        * SC2= Not used

0007                    PORT4    EQU   $0007     * Port 4 Data Register

                        * Bit0= (P40)  Home position for carrier
                        * Bit1= (P41)  Home position for tubes
                        * Bit2= (P42)  Home position for needles
                        * Bit3= (P43)  Carrier position
                        * Bit4= (P44)  Tubes position
                        * Bit5= (P45)  Needle position
                        * Bit6= (P46)  Not used
                        * Bit7= (P47)  Not used
```

```
                        **********************
                        * TIMER REGISTERS *
                        **********************

0008                    TCSREG   EQU   $0008     * Timer Control Stat
                                                  us Reg.

                        * BIT0= (OLVL) POL of Port2-1 When Output Com
                                                  pare
                        * BIT1= (IEDG) Polarity of Capture Clock
                        * BIT2= (ETOI) Enable Overflow IRQ2
                        * BIT3= (EOCI) Enable Output Compare IRQ2
                        * BIT4= (EICI) Enable Input Capture IRQ
                        * BIT5= (TOF)  Timer Overflow Flag
                        * BIT6= (OCF)  Output Compare Flag
                        * BIT7= (ICF)  Input  Capture Flag

0009                    FRCMSB   EQU   $0009     * Free Running Count
                                                  er MSB.
000A                    FRCLSB   EQU   $000A     * Free Running Count
                                                  er LSB

000B                    OCRMSB   EQU   $000B     * Output Capture Reg
                                                   MSB
000C                    OCRLSB   EQU   $000C     * Output Compare Reg
                                                   LSB

000D                    ICRMSB   EQU   $000D     * Input Capture Reg
                                                  MSB
000E                    ICRLSB   EQU   $000E     * Input Capture Reg
                                                  LSB

                        ********************************
                        * PORT IRQ CONTROL REGISTER *
                        ********************************

000F                    P3SREG   EQU   $000F     * Port 3 Status Reg.

                        * Bit0=
                        * Bit1=
                        * Bit2=
                        * Bit3= PORT3 Latch Enable
                        * Bit4= OSS (Output Strobe Sel.)
                        * Bit5=
                        * Bit6= IS3 IRQ1 Enable
                        * Bit7= IS3 Flag Bit

                        ****************************
                        * SERIAL PORT REGISTERS *
                        ****************************

0010                    RMCREC   EQU   $0010     * Rate Mode Control
                                                  Reg

                        * Bit0= (SS0) Baud Rate Select
                        * Bit1= (SS1) Baud Rate Select
                        * Bit2= (CC0) Format  Clk Source
                        * Bit3= (CC1) Format  Clk Source
                        * Bit4=
                        * Bit5=
                        * Bit6=
                        * Bit7=

0011                    TRCSRG   EQU   $0011     * Xmit Recieve Contr
                                                  ol & Status

                        * Bit0= (WU) Wake-up
                        * Bit1= (TE) Xmit Enable
                        * Bit2= (TIE) Xmit IRQ2 Enable
                        * Bit3= (RE) Recv Enable
                        * Bit4= (RIE) Recv IRQ2 Ebable
                        * Bit5= (TDRE) Xmit Data Reg Empty Flag
```

```
121                          * Bit6= (ORDE) Overrun Framing Error
122                          * Bit7= (RDRF) Recieve Data Reg Full
123
124     0012                 RCVREG   EQU   $0012      * Receive Data Regis
                                                       ter
125     0013                 XMTREG   EQU   $0013      * Transmit Data Regi
                                                       ster
126
127                          ************************************
128                          * RAM AND EPROM CONTROL REGISTERS *
129                          ************************************
130
131     0014                 RAMROM   EQU   $0014      * Ram Eprom Control
                                                       Reg.
132
133                          * Bit0= (PLC) Programing Latch Control
134                          * Bit1= (PPC) Programing Power Control
135                          * Bit2=
136                          * Bit3=
137                          * Bit4=
138                          * Bit5=
139                          * Bit6= (RAME) Enable Ram Addressing
140                          * Bit7= (STBY PWR) Standby Power Status Flag
141                          **** $0015-$001F RESERVED ! ****
142
143
144                          ********************************
145                          * STANDBY RAM ($0080-$00BF) *
146                          ********************************
147
148
149                          ********************************
150                          * TEMPORARY RAM ($00A0-$00FF) *
151                          ********************************
152
153     0080                 IRQMSK   EQU   $80        * DEBOUNCE MASK STAR
                                                       T SWITCH
154
155     0040                 TUBEENB  EQU   $40        *TUBE DRIVE ENABLE
156     0008                 TUBEMOTP EQU   $08        *TUBE MOTOR DRIVE PO
                                                       SITIVE.
157     0002                 TUBESW1  EQU   $02        *TUBE HOME SWITCH.
158     0004                 TUBETBRK EQU   $04        *TUBE TRIAC BRAKE
159     0004                 TUBEMOTN EQU   $04        *TUBE MOTOR DRIVE NE
                                                       GATIVE.
160     0010                 TUBESW2  EQU   $10        *TUBE DOWN POSITION
                                                       SWITCH.
161     00F3                 TUBEMSK  EQU   $F3        *MASKS OFF THE TUBE
                                                       DIRECTION BITS TO A
                                                       0.
162
163     0080                 CRGENB   EQU   $80        *CARRIAGE DRIVE ENAB
                                                       LE
164     0002                 CRGMOTP  EQU   $02        *CARRIAGE MOTOR DRIV
                                                       E POSTIVE.
165     0001                 CRGSW1   EQU   $01        *CARRIAGE HOME POSIT
                                                       ION SWITCH.
166     0001                 CRGTBRK  EQU   $01        *CARRIAGE TRIAC BRAK
                                                       E
167     0001                 CRGMOTN  EQU   $01        *CARRIAGE MOTOR DRIV
                                                       E NEGATIVE.
168     0008                 CRGSW2   EQU   $08        *CARRIAGE LOCATION S
                                                       WITCH.
169     00FC                 CRGMSK   EQU   $FC        *MASKS OFF THE CRG D
                                                       IRECTION BIT TO A 0.
170
171     0020                 NDLENB   EQU   $20        *MASK OFF THE NEEDLE
                                                        DIRECTION BITS TO A
                                                       0
172     0020                 NDLMOTP  EQU   $20        *NEEDLE MOTOR DRIVE
                                                       POSTIVE.
173     0004                 NDLSW1   EQU   $04        *NEEDLE HOME POSITIO
```

```
174     0010
175     0010
176     0020
177     00CF
178
179     0003
180     0040
181     0001
182     0002
183     0003
184     0004
185     0005
186     0006
187     0001
188     0002
189     0001
190     0002
191     0003
192     0004
193     0004
194     00FF
195     0015
196     00E0
197     0002
198     000F
199     5000
200     02FF
201     04FF
202     08FF
203     0FFF
204     1FFF
205     1FFF
206     0007
207     0006
208     00FF
209     00AF
210     0010
211     0080
212     0080
213     0081
214     0083
215     0084
216     0085
217     0086
218     0087
```

```
NDLTBRK   EQU   $10
NDLMOTN   EQU   $10
NDLSW2    EQU   $20
NDLMSK    EQU   $CF

CLEANYET  EQU   $03

TRAY      EQU   $40

WASH      EQU   $01
WASTE     EQU   $02
BLOT      EQU   $03
SAMPWELL  EQU   $04
DULUTER   EQU   $05
PLATE     EQU   $06
NDL1UL    EQU   $01
NDL5UL    EQU   $02
ERROR1    EQU   $01
ERROR2    EQU   $02
ERROR3    EQU   $03
ERROR4    EQU   $04
ETOI      EQU   $04

STACK     EQU   $FF
ALLBRAKE  EQU   $15
ALLENB    EQU   $E0
BRAKEPRT  EQU   PORT1
SWBOUNCE  EQU   $0F

JOGTIME   EQU   $5000
TONE1     EQU   $02FF

TONE2     EQU   $04FF

TONE3     EQU   $08FF
TONE4     EQU   $0FFF

TONE5     EQU   $1FFF
TONE      EQU   $1FFF

SWPRT     EQU   PORT4
MOTORPRT  EQU   PORT3
OFFSW     EQU   $00FF
SOAKTIME  EQU   $00AF
BLOTIME   EQU   $0010
          ORG   $0080
WASHTIMS  RMB   1
TONES     RMB   2
WATCHDOG  RMB   1
ENABLE    RMB   1

DIRECT    RMB   1

SWITCH    RMB   1

TBRAKE    RMB   1
```

```
N SWITCH.
*NEEDLE TRIAC BRAKE
*NEEDLE MOTOR DRIVE
NEGATIVE.
*NEEDLE LOCATION SWI
TCH.
*MASK OFF THE NDL DI
RECTION BIT TO A 0.

*HOW MANY TIMES TO C
YCLE THROUGH THE WAS
H CYCLE.
*TO MAKE SURE THE TR
AY IS ALL THE IN.
*CARRIAGE LOCATION O
NE.
*CARRIAGE LOCATION T
WO.
*CARRIAGE LOCATION T
HREE.
*CARRIAGE LOCATION F
OUR.

*CARRIAGE LOCATION F
IVE.
*NEEDLE LOCATION ONE
.
*NEEDLE LOCATION TWO
.
*TUBES NOT AT HOME P
OSITION.
*MOTOR NOT DRIVING.
*TRAY IS NOT ALL THE
 WAY IN.

*TIMER OVERFLOW FLAG
 IN THE TCSREG.
*TOP OF RAM.

*ALL MOTOR ENABLE

*WAITING FOR TUBE SW
ITCH TO STOP BOUNCIN
G.

*TUBE HOME POS. ERRO
R TONE.
*MOTOR NOT REACHING
LIMIT SWITCH TONE
*TRAY NOT IN TONE.
*SWITCH NOT CLOSED E
RROR.
*UNKNOWN ERROR.
*READY FOR OPERATION
 TONE.
*SWITCH PORT, PORT4
*MOTOR PORT, PORT3

*PAUSE TIME.


* MOTOR CONTROL BLOC
K ENABLE
* MOTOR CONTROL BLOC
K DIRECTION
* MOTOR CONTROL BLOC
K SWITCH
* MOTOR CONTROL BLOC
```

```
                                                          K TRIAC BRAKE
          0088                    MASK      RMB   1       * MOTOR CONTROL DIRE
                                                          CTION BIT MASK
          0089                    CRGPOS    RMB   1
          008A                    NDLPOS    RMB   1
          008B                    STATUS    RMB   1       * Mode Flag
          008C                    COUNT     RMB   1
                                  ***************************************
                                            MAC   START
                                  &L        LDAA  ENABLE
                                            COMA
                                            ANDA  BRAKEPRT
                                            STAA  BRAKEPRT  * DISABLE DRIVE
                                            LDAA  MASK
                                            ANDA  MOTORPRT  * ZERO DIRECTION BIT
                                                            S
                                            ORAA  DIRECT    * GET REQUIRED DIREC
                                                            TION
                                            STAA  MOTORPRT
                                            LDAA  ENABLE
                                            ORAA  BRAKEPRT
                                            STAA  BRAKEPRT  * ENABLE
     245R 008D                              MEN
                                            MAC   STOP
                                  &L        LDAA  ENABLE
                                            COMA
                                            ANDA  BRAKEPRT  * DISABLE DRIVE
                                            ORAA  TBRAKE    * TRIAC BRAKE
                                            STAA  BRAKEPRT  * BRAKE AND DISABLE
                                            LDAA  MASK
                                            ANDA  MOTORPRT
                                            STAA  MOTORPRT  * DRIVE FAST STOP
                                            LDAA  ENABLE
                                            ORAA  BRAKEPRT
                                            STAA  BRAKEPRT  * DRIVE FAST STOP
     490  008D                              MEN
                                  ***************************
          F800                              ORG   $F800
      2R  F800  0F                INIT      SEI
      8   F801  7F 008B                     CLR   STATUS
      14  F804  7F 008C                     CLR   COUNT
      16  F807  86 02                       LDAA  #$02
      20  F809  97 01                       STAA  P2DDR     *MAKES P21 AN OUTPUT
                                                            .
      22  F80B  4F                          CLRA
      26  F80C  97 08                       STAA  TCSREG
      28  F80E  43                          COMA
      30  F80F  C6 E0                       LDAB  #ALLENB
      32  F811  53                          COMB
      36  F812  97 00                       STAA  P1DDR     * PORT 1 ALL OUTPUT
      40  F814  D7 02                       STAB  BRAKEPRT  * SET ALL TRIAC BRAK
                                                            E,DISABLE DRIVE
      44  F816  97 04                       STAA  P3DDR     * PORT 3 ALL OUTPUT
      47  F818  CE 7FFF                     LDX   #$7FFF
      6R  F81B  7F 0006           !1        CLR   MOTORPRT  * MOTOR DRIVES FAST
                                                            STOP
      8   F81E  C6 E0                       LDAB  #ALLENB
      11  F820  DA 02                       ORAB  BRAKEPRT
      15  F822  D7 02                       STAB  BRAKEPRT  * ENABLE DRIVE FOR F
                                                            AST STOP
      18  F824  8E 00FF                     LDS   #STACK
      22  F827  09                          DEX
      26  F828  26 F1     (F81B)            BNE   !1
      2R  F82A  0E                          CLI
      11 *F82B  BD F9C9                     JSR   TUBEHOME
      20 *F82E  BD F9E3                     JSR   CRGHOME
      29 *F831  BD FA12                     JSR   NDLHOME
      38 *F834  BD FB15                     JSR   BEEPER
      44  F837  7F 0080                     CLR   WASHTIMS
      46  F83A  86 80                       LDAA  #$80
      51  F83C  B7 008B                     STAA  STATUS    * Mode READY
      60  F83F  3E                          WAI
```

```
283    2R F840  C6 E0              EXEC    LDAB  #ALLENB
284     4 F842  53                      COMB
285     8 F843  D7 02                    STAB  BRAKEPRT  *SETS THE TRIAC BRAK
                                                         ES, AND DISENABLES T
                                                         HE MOTORS.
286    14 F845  7F 0006                  CLR   MOTORPRT  *MOTOR DRIVERS FAST
                                                         STOP.
287    16 F848  C6 E0                    LDAB  #ALLENB
288    19 F84A  DA 02                    ORAB  BRAKEPRT
289    23 F84C  D7 02                    STAB  BRAKEPRT  *ENABLES MOTOR DRIVE
                                                         RS FOR FAST STOP.
290    3R F84E  CE 00FF            !7    LDX   #OFFSW
291    3R F851  96 07              !4    LDAA  SWPRT
292     5 F853  84 80                    ANDA  #IRQMSK
293     9 F855  27 F7      (F84E)        BEQ   !7
294    4R F857  09                      DEX
295     8 F858  26 F7      (F851)        BNE   !4
296
297    6R F85A  7D 008B                  TST   STATUS
298    10 F85D  26 01     (F860)         BNE   !2        * If Not = 0 Not INI
                                                         TL Mode
299    20 F85F  3B                      RTI
300    24 F860  2B 03     (F865)  !2    BMI   !3        * If -. READY Mode so
                                                         go RUN
301    3R F862  7E F800                  JMP   INIT      * If + RUN Mode so g
                                                         o INIT
302    2R F865  86 7F              !3    LDAA  #$7F
303     7 F867  B7 008B                  STAA  STATUS    * Flag RUN mode
304     9 F86A  0E                       CLI
305    12 F86B  8E 00FF                  LDS   #STACK
306    14 F86E  C6 01                    LDAB  #WASH
307    23 *F870 BD FAB7                  JSR   CRGLOC
308    32 *F873 BD F9D6                  JSR   TUBEDOWN
309    34  F876 C6 02                    LDAB  #NDL3UL
310    43 *F878 BD FAE6                  JSR   NDLLOC
311    52 *F87B BD F9C9                  JSR   TUBEHOME
312    54  F87E C6 02                    LDAB  #WASTE
313    63 *F880 BD FAB7                  JSR   CRGLOC
314    72 *F883 BD FA12                  JSR   NDLHOME
315    81 *F886 BD F9D6                  JSR   TUBEDOWN
316    90 *F889 BD F9C9                  JSR   TUBEHOME
317    92  F88C C6 03                    LDAB  #BLOT
318   101 *F88E BD FAB7                  JSR   CRGLOC
319   110 *F891 BD F9D6                  JSR   TUBEDOWN
320   119 *F894 BD FC33                  JSR   BLOTTER   *THE TIME THE TUBES
                                                         WILL STAY DOWN.
321   128 *F897 BD F9C9                  JSR   TUBEHOME
322   130  F89A C6 04                    LDAB  #SAMPWELL
323   139 *F89C BD FAB7                  JSR   CRGLOC
324   148 *F89F BD F9D6                  JSR   TUBEDOWN
325   150  F8A2 C6 01                    LDAB  #NDL1UL
326   159 *F8A4 BD FAE6                  JSR   NDLLOC
327   168 *F8A7 BD F9C9                  JSR   TUBEHOME
328   170  F8AA C6 03                    LDAB  #BLOT
329   179 *F8AC BD FAB7                  JSR   CRGLOC
330   188 *F8AF BD FA12                  JSR   NDLHOME
331   197 *F8B2 BD F9D6                  JSR   TUBEDOWN
332   206 *F8B5 BD FC33                  JSR   BLOTTER
333   215 *F8B8 BD F9C9                  JSR   TUBEHOME
334   217  F8BB C6 04                    LDAB  #SAMPWELL
335   226 *F8BD BD FAB7                  JSR   CRGLOC
336   235 *F8C0 BD F9D6                  JSR   TUBEDOWN
337   237  F8C3 C6 01                    LDAB  #NDL1UL
338   246 *F8C5 BD FAE6                  JSR   NDLLOC
339   255 *F8C8 BD F9C9                  JSR   TUBEHOME
340   258  F8CB 96 06                    LDAA  MOTORPRT
341   260  F8CD 84 50                    ANDA  #80
342   264  F8CF 26 3B      (F90C)        BNE   !10
343    2R F8D1 C6 01                    LDAB  #WASH
344    11 *F8D3 BD FAB7                  JSR   CRGLOC
345    20 *F8D6 BD F9D6                  JSR   TUBEDOWN
346    22  F8D9 C6 02                    LDAB  #NDL5UL
347    31 *F8DB BD FAE6                  JSR   NDLLOC
```

```
348   40 *F8DE   BD F9C9          JSR    TUBEHOME
349   42  F8E1   C6 05            LDAB   #DULUTER
350   51 *F8E3   BD FAB7          JSR    CRGLOC
351   60 *F8E6   BD FA12          JSR    NDLHOME
352   69 *F8E9   BD F9D6          JSR    TUBEDOWN
353   71  F8EC   C6 02            LDAB   #NDL5UL
354   80 *F8EE   BD FAE6          JSR    NDLLOC
355   89 *F8F1   BD FA12          JSR    NDLHOME
356   91  F8F4   C6 02            LDAB   #NDL5UL
357  100 *F8F6   BD FAE6          JSR    NDLLOC
358  109 *F8F9   BD FA12          JSR    NDLHOME
359  111  F8FC   C6 02            LDAB   #NDL5UL
360  120 *F8FE   BD FAE6          JSR    NDLLOC
361  129 *F901   BD FA12          JSR    NDLHOME
362  131  F904   C6 01            LDAB   #NDL1UL
363  140 *F906   BD FAE6          JSR    NDLLOC
364  149 *F909   BD F9C9          JSR    TUBEHOME
365   2R F90C   C6 06        !10  LDAB   #PLATE
366   11 *F90E   BD FAB7          JSR    CRGLOC
367   20 *F911   BD FA12          JSR    NDLHOME
368   29 *F914   BD F9D6          JSR    TUBEDOWN
369   38 *F917   BD FAA8          JSR    SOAK
370   47 *F91A   BD F9C9          JSR    TUBEHOME
371   49  F91D   C6 03            LDAB   #BLOT
372   58 *F91F   BD FAB7          JSR    CRGLOC
373   67 *F922   BD F9D6          JSR    TUBEDOWN
374   76 *F925   BD FC33          JSR    BLOTTER
375   85 *F928   BD F9C9          JSR    TUBEHOME
376   2R F92B   C6 01         !1  LDAB   #WASH
377   11 *F92D   BD FAB7          JSR    CRGLOC
378   20 *F930   BD F9D6          JSR    TUBEDOWN
379   22  F933   C6 02            LDAB   #NDL5UL
380   31 *F935   BD FAE6          JSR    NDLLOC
381   40 *F938   BD F9C9          JSR    TUBEHOME
382   42  F93B   C6 02            LDAB   #WASTE
383   51 *F93D   BD FAB7          JSR    CRGLOC
384   60 *F940   BD FA12          JSR    NDLHOME
385   69 *F943   BD F9D6          JSR    TUBEDOWN
386   78 *F946   BD F9C9          JSR    TUBEHOME
387   82  F949   B6 0080          LDAA   WASHTIMS
388   84  F94C   81 00            CMPA   #$00
389   88  F94E   27 08    (F958) BEQ    !5
390   2R F950   81 01            CMPA   #$01
391    6  F952   27 2F    (F983) BEQ    !6
392   2R F954   81 02            CMPA   #$02
393    6  F956   27 12    (F96A) BEQ    !8
394   2R F958   C6 03         !5 LDAB   #BLOT
395   11 *F95A   BD FAB7          JSR    CRGLOC
396   14  F95D   CE 5000          LDX    #JOGTIME  *HOW LONG TO LEAVE T
                                          HE MOTORS ON.
397   16  F960   86 02            LDAA   #CRGMOTP
398   21  F962   B7 0085          STAA   DIRECT
399   30 *F965   BD F990          JSR    JOG
400   34  F968   20 10    (F97A) BRA    !9
401   2R F96A   C6 03         !8 LDAB   #BLOT
402   11 *F96C   BD FAB7          JSR    CRGLOC
403   13  F96F   86 01            LDAA   #CRGMOTN
404   18  F971   B7 0085          STAA   DIRECT
405   21  F974   CE 5000          LDX    #JOGTIME  *HOW LONG TO LEAVE T
                                          HE MOTORS ON
406   30 *F977   BD F990          JSR    JOG
407   9R*F97A   BD F9D6       !9  JSR    TUBEDOWN
408   18 *F97D   BD FC33          JSR    BLOTTER
409   27 *F980   BD F9C9          JSR    TUBEHOME
410   6R F983   7C 0080       !6  INC    WASHTIMS
411    8  F986   86 03            LDAA   #CLEANYET
412   12  F988   B1 0080          CMPA   WASHTIMS
413   16  F98B   26 9E    (F92B) BNE    !1
414   3R F98D   7E F800          JMP    INIT
415   9R*F990   BD FC42      JOG JSR    BRAKOFF
416       F993                   START
```

```
416  13  F993  B6 0084      +          LDAA  ENABLE
416  15  F996  43           +          COMA
416  18  F997  94 02        +          ANDA  BRAKEPRT
416  22  F999  97 02        +          STAA  BRAKEPRT  * DISABLE DRIVE
416  26  F99B  B6 0088      +          LDAA  MASK
416  29  F99E  94 06        +          ANDA  MOTORPRT  * ZERO DIRECTION BIT
                                                      S
416  33  F9A0  BA 0085      +          ORAA  DIRECT    * GET REQUIRED DIREC
                                                      TION
416  37  F9A3  97 06        +          STAA  MOTORPRT
416  41  F9A5  B6 0084      +          LDAA  ENABLE
416  44  F9A8  9A 02        +          ORAA  BRAKEPRT
416  48  F9AA  97 02        +          STAA  BRAKEPRT  * ENABLE
417   4R F9AC  09             !1       DEX
418   8  F9AD  26 FD      (F9AC)       BNE   !1
419      F9AF                          STOP
419   4R F9AF  B6 0084          +      LDAA  ENABLE
419   6  F9B2  43              +      COMA
419   9  F9B3  94 02           +      ANDA  BRAKEPRT  * DISABLE DRIVE
419  13  F9B5  BA 0087         +      ORAA  TBRAKE    * TRIAC BRAKE
419  17  F9B8  97 02           +      STAA  BRAKEPRT  * BRAKE AND DISABLE
419  21  F9BA  B6 0088         +      LDAA  MASK
419  24  F9BD  94 06           +      ANDA  MOTORPRT
419  28  F9BF  97 06           +      STAA  MOTORPRT  * DRIVE FAST STOP
419  32  F9C1  B6 0084         +      LDAA  ENABLE
419  35  F9C4  9A 02           +      ORAA  BRAKEPRT
419  39  F9C6  97 02           +      STAA  BRAKEPRT  * DRIVE FAST STOP
420  44  F9C8  39                     RTS
421   2R F9C9  C6 01           TUBEHOME LDAB  #$01
422   5  F9CB  CE F9D1                 LDX   #!1
423   8  F9CE  7E FB69                 JMP   DRIVE!9
424      F9D1  40                 !1   FCB   TUBEENB
425      F9D2  08                      FCB   TUBEMOTP
426      F9D3  02                      FCB   TUBESW1
427      F9D4  04                      FCB   TUBETBRK
428      F9D5  F3                      FCB   TUBEMSK
429   2R F9D6  C6 01           TUBEDOWN LDAB  #$01
430   5  F9D8  CE F9DE                 LDX   #!1
431   8  F9DB  7E FB66                 JMP   DRIVE
432      F9DE  40                 !1   FCB   TUBEENB
433      F9DF  04                      FCB   TUBEMOTN
434      F9E0  10                      FCB   TUBESW2
435      F9E1  04                      FCB   TUBETBRK
436      F9E2  F3                      FCB   TUBEMSK
437   6R F9E3  7F 0089         CRGHOME  CLR   CRGPOS
438  15 *F9E6  BD FA2D                 JSR   CHECKTUB
439  18  F9E9  CE F9F1                 LDX   #!1
440  20  F9EC  C6 01                   LDAB  #$01
441  23  F9EE  7E FB66                 JMP   DRIVE
442      F9F1  80                 !1   FCB   CRGENB
443      F9F2  02                      FCB   CRGMOTP
444      F9F3  01                      FCB   CRGSW1
445      F9F4  01                      FCB   CRGTBRK
446      F9F5  FC                      FCB   CRGMSK
447   9R*F9F6  BD FA2D         CRGBACK  JSR   CHECKTUB
448  12  F9F9  CE F9FF                 LDX   #!1
449  15  F9FC  7E FB66                 JMP   DRIVE
450      F9FF  80                 !1   FCB   CRGENB
451      FA00  01                      FCB   CRGMOTN
452      FA01  08                      FCB   CRGSW2
453      FA02  01                      FCB   CRGTBRK
454      FA03  FC                      FCB   CRGMSK
455   9R*FA04  BD FA2D         CRGFRONT JSR   CHECKTUB
456  12  FA07  CE FA0D                 LDX   #!1
457  15  FA0A  7E FB66                 JMP   DRIVE
458      FA0D  80                 !1   FCB   CRGENB
459      FA0E  02                      FCB   CRGMOTP
460      FA0F  08                      FCB   CRGSW2
461      FA10  01                      FCB   CRGTBRK
462      FA11  FC                      FCB   CRGMSK
463   6R FA12  7F 008A         NDLHOME  CLR   NDLPOS
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464    8   FA15   C6 01                    LDAB   #$01
465   11   FA17   CE FA1D                  LDX    #!1
466   14   FA1A   7E FB69                  JMP    DRIVE!9
467        FA1D   20              !1       FCB    NDLENB
468        FA1E   20                       FCB    NDLMOTP
469        FA1F   04                       FCB    NDLSW1
470        FA20   10                       FCB    NDLTBRK
471        FA21   CF                       FCB    NDLMSK
472   3R   FA22   CE FA28          NDL1UL5  LDX    #!1
473   6    FA25   7E FB69                  JMP    DRIVE!9
474        FA28   20              !1       FCB    NDLENB
475        FA29   10                       FCB    NDLMOTN
476        FA2A   20                       FCB    NDLSW2
477        FA2B   10                       FCB    NDLTBRK
478        FA2C   CF                       FCB    NDLMSK
479   2R   FA2D   86 0F            CHECKTUB LDAA   #SWBOUNCE
480   3R   FA2F   CE 03FF          !2       LDX    #$03FF
481   4R   FA32   09              !1       DEX
482   8    FA33   26 FD      (FA32)        BNE    !1
483   2R   FA35   4A                       DECA
484   6    FA36   26 F7      (FA2F)        BNE    !2
485   2R   FA38   86 02                    LDAA   #TUBESW1
486   5    FA3A   94 07                    ANDA   SWPRT
487   9    FA3C   27 05      (FA43)        BEQ    !3
488   2R   FA3E   86 01                    LDAA   #ERROR1
489   5    FA40   7E FB38                  JMP    BEEPERRO
490  10    FA43   39              !3       RTS
491   3R   FA44   96 08          UPDATIME LDAA   TCSREG     *CLEARS IRQ
492   6    FA46   96 09                    LDAA   TCSREG+1
493  12    FA48   7C 0083                  INC    WATCHDOG
494  16    FA4B   27 01      (FA4E)        BEQ    !1
495  26    FA4D   3B                       RTI
496        FA4E                !1          STOP
496   4R   FA4E   B6 0084           +!1     LDAA   ENABLE
496   6    FA51   43              +        COMA
496   9    FA52   94 02           +        ANDA   BRAKEPRT   * DISABLE DRIVE
496  13    FA54   BA 0087         +        ORAA   TBRAKE     * TRIAC BRAKE
496  17    FA57   97 02           +        STAA   BRAKEPRT   * BRAKE AND DISABLE
496  21    FA59   B6 0088         +        LDAA   MASK
496  24    FA5C   94 06           +        ANDA   MOTORPRT
496  28    FA5E   97 06           +        STAA   MOTORPRT   * DRIVE FAST STOP
496  32    FA60   B6 0084         +        LDAA   ENABLE
496  35    FA63   9A 02           +        ORAA   BRAKEPRT
496  39    FA65   97 02           +        STAA   BRAKEPRT   * DRIVE FAST STOP
497  42    FA67   96 08                    LDAA   TCSREG
498  44    FA69   84 FB                    ANDA   #$FB
499  48    FA6B   97 08                    STAA   TCSREG
500  50    FA6D   0E                       CLI
501  52    FA6E   86 02                    LDAA   #ERROR2
502  55    FA70   7E FB38                  JMP    BEEPERRO
503   2R   FA73   86 40          TRAYIN   LDAA   #TRAY
504   5    FA75   94 07                    ANDA   SWPRT
505   9    FA77   26 01      (FA7A)        BNE    !1
506  14    FA79   39                       RTS
507   9R*FA7A   BD FA12          !1       JSR    NDLHOME
508  18 *FA7D   BD F9C9                    JSR    TUBEHOME
509  27 *FA80   BD FC33                    JSR    BLOTTER
510  29  FA83   C6 02                    LDAB   #NDL5UL
511  38 *FA85   BD FAE6                    JSR    NDLLOC
512  47  FA88   3E                       WAI
513   6R FA89   FF 0081          FLASH    STX    TONES
514   9R*FA8C   BD FB18          !2       JSR    BEEPER!1
515   3R FA8F   CE 0000          !3       LDX    #$0000
516   4R FA92   08               !1       INX
517   8  FA93   26 FD      (FA92)        BNE    !1
518   4R FA95   B6 008C                    LDAA   COUNT
519   6  FA98   4C                       INCA
520  11  FA99   B7 008C                    STAA   COUNT
521  13  FA9C   81 01                    CMPA   #$01
522  17  FA9E   26 EF      (FA8F)        BNE    !3
523   6R FAA0   7F 008C                    CLR    COUNT
524  11  FAA3   FE 0081                    LDX    TONES
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525   15   FAA6   20 E4      (FA8C)          BRA    !2
526    3R  FAA8   CE 00AF                SOAK  LDX    #SOAKTIME
527    3R  FAAB   96 08                  !1    LDAA   TCSREG
528    6   FAAD   D6 09                        LDAB   FRCMSB
529    8   FAAF   84 20                        ANDA   #$20
530   12   FAB1   27 F8      (FAAB)            BEQ    !1
531    4R  FAB3   09                          DEX
532    8   FAB4   26 F5      (FAAB)            BNE    !1
533   13   FAB6   39                          RTS
534    2R  FAB7   17                    CRGLOC TBA
535    6   FAB8   F0 0089                      SUBB   CRGPOS
536   10   FABB   24 15      (FAD2)            BCC    !1
537    2R  FABD   50                          NEGB
538    7   FABE   B7 0089                      STAA   CRGPOS
539    9   FAC1   86 01                        LDAA   #CRGSW1
540   12   FAC3   94 07                        ANDA   SWPRT
541   16   FAC5   27 08      (FACF)            BEQ    !2
542    2R  FAC7   86 08                        LDAA   #CRGSW2
543    5   FAC9   94 07                        ANDA   SWPRT
544    9   FACB   26 02      (FACF)            BNE    !2
545    2R  FACD   CB 01                        ADDB   #$01
546    3R  FACF   7E FA04                !2    JMP    CRGFRONT
547    5R  FAD2   B7 0089                !1    STAA   CRGPOS
548    7   FAD5   86 01                        LDAA   #CRGSW1
549   10   FAD7   94 07                        ANDA   SWPRT
550   14   FAD9   27 08      (FAE3)            BEQ    !3
551    2R  FADB   86 08                        LDAA   #CRGSW2
552    5   FADD   94 07                        ANDA   SWPRT
553    9   FADF   26 02      (FAE3)            BNE    !3
554    2R  FAE1   CB 01                        ADDB   #$01
555    3R  FAE3   7E F9F6                !3    JMP    CRGBACK
556    2R  FAE6   17                    NDLLOC TBA
557    6   FAE7   F0 008A                      SUBB   NDLPOS
558   10   FAEA   24 15      (FB01)            BCC    !1
559    2R  FAEC   50                          NEGB
560    7   FAED   B7 008A                      STAA   NDLPOS
561    9   FAF0   86 04                        LDAA   #NDLSW1
562   12   FAF2   94 07                        ANDA   SWPRT
563   16   FAF4   27 08      (FAFE)            BEQ    !2
564    2R  FAF6   86 20                        LDAA   #NDLSW2
565    5   FAF8   94 07                        ANDA   SWPRT
566    9   FAFA   26 02      (FAFE)            BNE    !2
567    2R  FAFC   CB 01                        ADDB   #$01
568    3R  FAFE   7E FA12                !2    JMP    NDLHOME
569    5R  FB01   B7 008A                !1    STAA   NDLPOS
570    7   FB04   86 04                        LDAA   #NDLSW1
571   10   FB06   94 07                        ANDA   SWPRT
572   14   FB08   27 08      (FB12)            BEQ    !3
573    2R  FB0A   86 20                        LDAA   #NDLSW2
574    5   FB0C   94 07                        ANDA   SWPRT
575    9   FB0E   26 02      (FB12)            BNE    !3
576    2R  FB10   CB 01                        ADDB   #$01
577    3R  FB12   7E FA22                !3    JMP    NDL1UL5
578    3R  FB15   CE 1FFF                BEEPER LDX    #TONE
579    3R  FB18   D6 08                  !1    LDAB   TCSREG
580    5   FB1A   C5 40                        BITB   #$40
581    9   FB1C   27 FA      (FB18)            BEQ    !1
582    2R  FB1E   C8 01                        EORB   #$01
583    6   FB20   D7 08                        STAB   TCSREG
584    9   FB22   D6 0C                        LDAB   OCRLSB
585   11   FB24   CB C8                        ADDB   #$C8
586   15   FB26   D7 0C                        STAB   OCRLSB
587   18   FB28   D6 0B                        LDAB   OCRMSB
588   20   FB2A   C9 00                        ADCB   #$00
589   24   FB2C   D7 0B                        STAB   OCRMSB
590   28   FB2E   09                          DEX
591   32   FB2F   26 E7      (FB18)            BNE    !1
592    3R  FB31   D6 08                        LDAB   TCSREG
593    5   FB33   84 FE                        ANDA   #$FE
594    9   FB35   D7 08                        STAB   TCSREG
595   14   FB37   39                          RTS
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596    2R FB38  81 01                BEEPERRO CMPA   #ERROR1
597    6  FB3A  26 06      (FB42)             BNE    !1
598    3R FB3C  CE 02FF                      LDX    #TONE1
599    6  FB3F  7E FA89                      JMP    FLASH
600    2R FB42  81 02                !1      CMPA   #ERROR2
601    6  FB44  26 06      (FB4C)             BNE    !2
602    3R FB46  CE 04FF                      LDX    #TONE2
603    6  FB49  7E FA89                      JMP    FLASH
604    2R FB4C  81 03                !2      CMPA   #ERROR3
605    6  FB4E  26 06      (FB56)             BNE    !3
606    3R FB50  CE 08FF                      LDX    #TONE3
607    6  FB53  7E FA89                      JMP    FLASH
608    2R FB56  81 04                !3      CMPA   #ERROR4
609    6  FB58  26 06      (FB60)             BNE    !4
610    3R FB5A  CE 0FFF                      LDX    #TONE4
611    6  FB5D  7E FA89                      JMP    FLASH
612    3R FB60  CE 1FFF                !4    LDX    #TONE5
613    6  FB63  7E FA89                      JMP    FLASH
614    9R*FB66  BD FA73                DRIVE JSR    TRAYIN
615    2R FB69  0F                     !9    SEI
616    7  FB6A  A6 00                        LDAA   0,X          * SAVE MOTOR CONTROL
                                                                  BLOCK
617   12  FB6C  B7 0084                      STAA   ENABLE
618   17  FB6F  A6 01                        LDAA   1,X
619   22  FB71  B7 0085                      STAA   DIRECT
620   27  FB74  A6 02                        LDAA   2,X
621   32  FB76  B7 0086                      STAA   SWITCH
622   37  FB79  A6 03                        LDAA   3,X
623   42  FB7B  B7 0087                      STAA   TBRAKE
624   47  FB7E  A6 04                        LDAA   4,X
625   52  FB80  B7 0088                      STAA   MASK
626   61 *FB83  BD FC42                      JSR    BRAKOFF
627   64  FB86  96 08                        LDAA   TCSREG
628   67  FB88  96 09                        LDAA   TCSREG+1
629   69  FB8A  86 04                        LDAA   #ETOI
630   73  FB8C  97 08                        STAA   TCSREG
631   79  FB8E  7F 0083                      CLR    WATCHDOG
632   81  FB91  0E                           CLI
633   85  FB92  B6 0086                      LDAA   SWITCH       *SWITCH MASK
634   88  FB95  94 07                        ANDA   SWPRT
635   92  FB97  27 20      (FBB9)            BEQ    !1
636       FB99                               START
636    4R FB99  B6 0084                +     LDAA   ENABLE
636    6  FB9C  43                     +     COMA
636    9  FB9D  94 02                  +     ANDA   BRAKEPRT
636   13  FB9F  97 02                  +     STAA   BRAKEPRT    * DISABLE DRIVE
636   17  FBA1  B6 0088                +     LDAA   MASK
636   20  FBA4  94 06                  +     ANDA   MOTORPRT    * ZERO DIRECTION BIT
                                                                  S
636   24  FBA6  BA 0085                +     ORAA   DIRECT      * GET REQUIRED DIREC
                                                                  TION
636   28  FBA9  97 06                  +     STAA   MOTORPRT
636   32  FBAB  B6 0084                +     LDAA   ENABLE
636   35  FBAE  9A 02                  +     ORAA   BRAKEPRT
636   39  FBB0  97 02                  +     STAA   BRAKEPRT    * ENABLE
637    4R FBB2  B6 0086                !2    LDAA   SWITCH      *AT SWITCH YET?
638    7  FBB5  94 07                        ANDA   SWPRT
639   11  FBB7  26 F9      (FBB2)            BNE    !2
640    2R FBB9  5A                     !1    DECB               *ACCB IS KEEPING TRA
                                                                  CK OF SWITCH CLOSURE
                                                                  S.
641    6  FBBA  26 02      (FBBE)            BNE    !3          *IF THIS IS THE RIGH
                                                                  T SWITCH THEN STOP, I
                                                                  F NOT CONNTINUE.
642   10  FBBC  20 30      (FBEE)            BRA    !4
643       FBBE                          !3    START
643    4R FBBE  B6 0084                +!3   LDAA   ENABLE
643    6  FBC1  43                     +     COMA
643    9  FBC2  94 02                  +     ANDA   BRAKEPRT
643   13  FBC4  97 02                  +     STAA   BRAKEPRT    * DISABLE DRIVE
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643  17  FBC6  B6 0088          +          LDAA  MASK
643  20  FBC9  94 06            +          ANDA  MOTORPRT  * ZERO DIRECTION BIT
                                                          S
643  24  FBCB  BA 0085          +          ORAA  DIRECT    * GET REQUIRED DIREC
                                                          TION
643  28  FBCE  97 06            +          STAA  MOTORPRT
643  32  FBD0  B6 0084          +          LDAA  ENABLE
643  35  FBD3  9A 02            +          ORAA  BRAKEPRT
643  39  FBD5  97 02            +          STAA  BRAKEPRT  * ENABLE
644   3R FBD7  CE 00FF            !5       LDX   #OFFSW    *MAKE SURE THAT IT I
                                                          S REALLY OFF THE SWI
                                                          TCH.
645   4R FBDA  B6 0086            !6       LDAA  SWITCH
646   7  FBDD  94 07                       ANDA  SWPRT
647  11  FBDF  27 F6      (FBD7)           BEQ   !5
648   4R FBE1  09                         DEX
649   8  FBE2  26 F6      (FBDA)           BNE   !6
650   4R FBE4  B6 0086              !7     LDAA  SWITCH
651   7  FBE7  94 07                       ANDA  SWPRT
652  11  FBE9  26 F9      (FBE4)           BNE   !7
653   2R FBEB  5A                         DECB
654   6  FBEC  26 E9      (FBD7)           BNE   !5
655      FBEE                       !4     STOP
655   4R FBEE  B6 0084            +!4      LDAA  ENABLE
655   6  FBF1  43                 +        COMA
655   9  FBF2  94 02              +        ANDA  BRAKEPRT  * DISABLE DRIVE
655  13  FBF4  BA 0087            +        ORAA  TBRAKE    * TRIAC BRAKE
655  17  FBF7  97 02              +        STAA  BRAKEPRT  * BRAKE AND DISABLE
655  21  FBF9  B6 0088            +        LDAA  MASK
655  24  FBFC  94 06              +        ANDA  MOTORPRT
655  28  FBFE  97 06              +        STAA  MOTORPRT  * DRIVE FAST STOP
655  32  FC00  B6 0084            +        LDAA  ENABLE
655  35  FC03  9A 02              +        ORAA  BRAKEPRT
655  39  FC05  97 02              +        STAA  BRAKEPRT  * DRIVE FAST STOP
656  42  FC07  96 08                       LDAA  TCSREG
657  44  FC09  84 FB                       ANDA  #$FB
658  48  FC0B  97 08                       STAA  TCSREG
659  54  FC0D  7F 0083                     CLR   WATCHDOG
660   3R FC10  96 08              !10      LDAA  TCSREG    *CHECKING THE TIMER
                                                          OVERFLOW BIT.
661   6  FC12  D6 09                       LDAB  TCSREG+1
662   8  FC14  84 20                       ANDA  #$20
663  12  FC16  27 F8      (FC10)           BEQ   !10
664   6R FC18  7C 0083                     INC   WATCHDOG  *HOW LONG TO WAIT BE
                                                          FORE CHECKING SWITCH
                                                          .
665  10  FC1B  B6 0083                     LDAA  WATCHDOG
666  12  FC1E  81 03                       CMPA  #$03
667  16  FC20  26 EE      (FC10)           BNE   !10
668   6R FC22  7F 0083                     CLR   WATCHDOG
669  10  FC25  B6 0086                     LDAA  SWITCH
670  13  FC28  94 07                       ANDA  SWPRT
671  17  FC2A  27 05      (FC31)           BEQ   !11
672   2R FC2C  86 04                       LDAA  #ERROR4
673   5  FC2E  7E FB38                     JMP   BEEPERRO
674  10  FC31  39                  !11      RTS
675  15  FC32  39                           RTS
676   3R FC33  CE 0010          BLOTTER    LDX   #BLOTIME
677   3R FC36  96 08              !1       LDAA  TCSREG
678   6  FC38  D6 09                       LDAB  FRCMSB
679   8  FC3A  84 20                       ANDA  #$20
680  12  FC3C  27 F8      (FC36)           BEQ   !1
681   4R FC3E  09                         DEX
682   8  FC3F  26 F5      (FC36)           BNE   !1
683  13  FC41  39                         RTS
684   4R FC42  B6 0087          BRAKOFF    LDAA  TBRAKE
685   6  FC45  43                         COMA
686   9  FC46  94 02                       ANDA  BRAKEPRT
687  13  FC48  97 02                       STAA  BRAKEPRT
688  15  FC4A  4F                          CLRA
689   2R FC4B  4A                 !1       DECA
690   6  FC4C  26 FD      (FC4B)           BNE   !1
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691   11   FC4E  39          RTS
692        FFF0               ORG   *FFF0
693        FFF0  F800         FDB   INIT        * SCI OF THE TCSREG.

694        FFF2  FA44         FDB   UPDATIME    * TIMER OVERFLOW BIT
695        FFF4  F800         FDB   INIT        * OCI OF THE TCSREG.

696        FFF6  F800         FDB   INIT        * ICI OF THE TCSREG.

697        FFF8  F840         FDB   EXEC        * IRQ
698        FFFA  F800         FDB   INIT        * SWI
699        FFFC  F800         FDB   INIT        * NMI
700        FFFE  F800         FDB   INIT        * RESET
701        0000               END

 NO ERRORS DETECTED

0015 ALLBRAKE    195
00E0 ALLENB      196   261   268   283   287
FB15 BEEPER      578   278   514
FB38 BEEPERRO    596   489   502   673
0003 BLOT        183   317   328   371   394   401
0010 BLOTIME     210   676
FC33 BLOTTER     676   320   332   374   408   509
0002 BRAKEPRT    197   264   269   270   285   288   289   416   416   416
                       416   419   419   419   419   496   496   496   496
                       636   636   636   636   643   643   643   643   655
                       655   655   655   686   687
FC42 BRAKOFF     684   415   626
FA2D CHECKTUB    479   438   447   455
0003 CLEANYET    179   411
008C COUNT       223   255   518   520   523
F9F6 CRGBACK     447   555
0080 CRGENB      163   442   450   458
FA04 CRGFRONT    455   546
F9E3 CRGHOME     437   276
FAB7 CRGLOC            307   313   318   323   329   335   344   350   366
                 534   372   377   383   395   402
0001 CRGMOTN     167   403   451
0002 CRGMOTP     164   397   443   459
00FC CRGMSK      169   446   454   462
0089 CRGPOS      220   437   535   538   547
0001 CRGSW1      165   444   539   548
0008 CRGSW2      168   452   460   542   551
0001 CRGTBRK     166   445   453   461
0085 DIRECT      216   398   404   416   619   636   643
FB66 DRIVE       614   423   431   441   449   457   466   473
0005 DULUTER     185   349
0084 ENABLE      215   416   416   419   419   496   496   617   636   636
                       643   643   655   655
0001 ERROR1      189   488   596
0002 ERROR2      190   501   600
0003 ERROR3      191   604
0004 ERROR4      192   608   672
0004 ETOI        193   629
FB40 EXEC        283   697
FA89 FLASH       513   599   603   607   611   613
000A FRCLSB       75
0009 FRCMSB       74   528   678
000E ICRLSB       81
000D ICRMSB       80
F800 INIT        253   301   414   693   695   696   698   699   700
0080 IRQMSK      153   292
F990 JOG         415   399   406
5000 JOGTIME     199   396   405
0088 MASK        219   416   419   496   625   636   643   655
0006 MOTORPRT    207   267   286   340   416   416   419   419   496   496
                       636   636   643   643   655   655
0001 NDL1UL      187   325   337   362
FA22 NDL1UL5     472   577
0002 NDL5UL      188   309   346   353   356   359   379   510
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0020 NDLENB      171   467  474
FA12 NDLHOME           277  314  330  351  355  358  361  367  384
                 463   507  568
FAE6 NDLLOC            310  326  338  347  354  357  360  363  380
                 556   511
0010 NDLMOTN     175   475
0020 NDLMOTP     172   468
00CF NDLMSK      177   471  478
008A NDLPOS      221   463  557  560  569
0004 NDLSW1      173   469  561  570
0020 NDLSW2      176   476  564  573
0010 NDLTBRK     174   470  477
000C OCRLSB       78   584  586
000B OCRMSB       77   587  589
00FF OFFSW       208   290  644
0000 P1DDR         9   263
0001 P2DDR        10   257
0004 P3DDR        32   265
000F P3SREG       87
0005 P4DDR        33
0006 PLATE       186   365
0002 PORT1        12   197
0003 PORT2        24
0006 PORT3        35   207
0007 PORT4        48   206
0014 RAMROM      131
0012 RCVREG      124
0010 RMCREG      102
0004 SAMPWELL    184   322  334
FAA8 SOAK        526   369
00AF SOAKTIME    209   526
00FF STACK       194   271  305
008B STATUS      222   254  281  297  303
000F SWBOUNCE    198   479
0086 SWITCH      217   621  633  637  645  650  669
0007 SWPRT       206   291  486  504  540  543  549  552  562  565
                       571  574  634  638  646  651  670
0087 TBRAKE      218   419  496  623  655  684
0008 TCSREG       63   259  491  492  497  499  527  579  583  592
                       594  627  628  630  656  658  660  661  677
1FFF TONE        205   578
02FF TONE1       200   598
04FF TONE2       201   602
08FF TONE3       202   606
0FFF TONE4       203   610
1FFF TONE5       204   612
0081 TONES       213   513  524
0040 TRAY        180   503
FA73 TRAYIN      503   614
0011 TRCSRG      113
F9D6 TUBEDOWN          308  315  319  324  331  336  345  352  368
                 429   373  378  385  407
0040 TUBEENB     155   424  432
F9C9 TUBEHOME          275  311  316  321  327  333  339  348  364
                 421   370  375  381  386  409  508
0004 TUBEMOTN    159   433
0008 TUBEMOTP    156   425
00F3 TUBEMSK     161   428  436
0002 TUBESW1     157   426  485
0010 TUBESW2     160   434
0004 TUBETBRK    158   427  435
FA44 UPDATIME    491   694
0001 WASH        181   306  343  376
0080 WASHTIMS    212   279  387  410  412
0002 WASTE       182   312  382
0083 WATCHDOG    214   493  631  659  664  665  668
0013 XMTREG      125
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What is claimed is:

1. Automatic pipetting apparatus comprising

a base,

sample plate means disposed on said base, said sample plate means having longitudinal and lateral dimensions, said plate means including a lateral row of liquid sample chambers and a lateral application space longitudinally separated from said liquid chamber row, said lateral application space adapted to receive a microporous support medium, said sample chambers adapted to receive liquid samples,

a pipette frame including vertical support means for supporting said frame from said base laterally above said sample plate means, said pipette frame having a longitudinal position with respect to said longitudinal dimension of said sample plate means,

longitudinal translation means for changing the longitudinal position between said pipette frame and said sample plate means,

a mounting plate carried by said pipette frame,

vertical translation means for effecting relative vertical movement of said mounting plate and said sample plate means,

a plurality of microsyringe barrels having their heads secured in a row to said mounting plate, said barrels spaced corresponding to the spacing of said liquid chambers on said plate, said barrels being hollow with each having a lower tip,

a plurality of micro-plungers, each of said plungers disposed in one of said barrels,

plunger translation means for moving said plungers vertically within said barrels,

signalling means

for generating longitudinal signals representative of the relative longitudinal orientation of said pipette frame with respect to said sample plate means,

for generating mounting plate signals representative of the vertical orientation of said mounting plate relative to said sample plate means and

for generating plunger signals representative of the orientation of said plungers relative to said barrels, and

programmed computer means responsive to said longitudinal signals, to said mounting plate signals and to said plunger signals for generating a sequence of control signals to said longitudinal translation means, to said vertical translation means and to said plunger translation means to aspirate a first predetermined amount of liquid from said sample chambers into said respective pipette barrels, and to apply a droplet of said liquid samples in each of said pipette barrels onto corresponding spaces of said microporous support medium when placed on said lateral application space of said sample plate by precisely positioning said lower tips of said barrels at a small distance above said microporous support medium, said small distance being smaller than the diameter of a droplet of liquid sample which may be maintained on the end of said tips through surface tension forces of the barrel tips, whereby each droplet slightly touches said microporous support medium and is thereby relieved of its surface tension and is precisely transferred to said microporous support medium from each of said pipette barrels.

2. The apparatus of claim 1 wherein

said sample plate means is translated longitudinally beneath said pipette frame by said longitudinal translation means.

3. The apparatus of claim 1 wherein

said pipette frame is translated longitudinally above said sample plate means by said longitudinal translation means.

4. The apparatus of claim 1 wherein said sample plate means includes a wash well adapted to contain wash liquid and a waste well longitudinally spaced from each other and from said sample chambers,

said programmed computer means generating a further sequence of control signals to said longitudinal translation means, to said vertical translation means and to said plunger translation means before aspirating liquid from said sample chambers,

to draw a second predetermined amount of wash liquid from said wash well into respective pipette barrels, and

to discharge said wash liquid into said waste well.

5. The apparatus of claim 1 wherein said sample plate means further includes a wash well adapted to contain wash liquid and a waste well longitudinally spaced from each other and from said sample chambers and a row of individual liquid dilution wells longitudinally spaced from said sample chambers, said dilution wells adapted to receive dilution liquid,

said programmed computer means generating a further sequence of control signal to said longitudinal translation means, to said vertical translation means and to said plunger translation means after aspirating liquid samples of said liquid samples into said pipette barrels,

to aspirate a second predetermined amount of wash fluid from said wash well into said respective pipette barrels operably creating a combination of sample liquid and wash liquid in each barrel,

to discharge said sample liquid/wash liquid into said corresponding dilution wells operably creating diluted liquid samples, and

to aspirate a third predetermined amount of diluted liquid samples from said dilution wells into said respective pipette barrels.

6. The apparatus of claim 5 wherein

said programmed computer means generates a further sequence of control signals to said plunger translation means to alternatingly discharge said sample liquid/wash liquid into said corresponding dilution wells and aspirate a predetermined amount of diluted liquid from said dilution wells into said respective pipette barrels operatively causing mixing of said liquid samples with said dilution liquid in said dilution wells.

7. The apparatus of claim 4 wherein said sample plate means further includes a row of individual liquid dilution wells longitudinally spaced from said sample chambers, said dilution wells adapted to receive dilution liquid,

said programmed computer means generating a further sequence of control signals to said longitudinal translation means, to said vertical translation means and to said plunger translation means for applying said first predetermined amount of liquid sample in each barrel to said dilution wells, applying a third predetermined amount of wash liquid from each barrel to said dilution wells, mixing the combination of said wash liquid and said liquid sample of said dilution wells, and aspirating an amount of

diluted liquid samples from said dilution wells into said respective pipette barrels.

8. Automatic pipetting apparatus comprising a base,
sample plate means disposed on said base, said sample plate means having longitudinal and lateral dimensions, said plate means including a lateral row of liquid sample chambers and a lateral application space longitudinally separated from said liquid chamber row, said lateral application space adapted to receive a microporous support medium, said sample chambers adapted to receive liquid samples,
a pipette frame including vertical support means for supporting said frame from said base laterally above said sample plate means, said pipette frame having a longitudinal position with respect to said longitudinal dimension of said sample plate means,
longitudinal translation means for changing the relative longitudinal position between said pipette frame and said sample plate means,
a mounting plate carried by said pipette frame,
vertical translation means for effecting relative vertical movement of said mounting plate and said sample plate means,
a plurality of microsyringe barrels having their heads secured in a row to said mounting plate, said barrels spaced corresponding to the spacing of said liquid chambers on said plate, said barrels being hollow with each having a lower tip,
a plurality of micro-plungers, each of said plungers disposed in one of said barrels,
plunger translation means for moving said plungers vertically within said barrels,
signalling means
for generating longitudinal signals representative of the relative longitudinal orientation of said pipette frame with respect to said sample plate means,
for generating mounting plate signals representative of the vertical orientation of said mounting plate relative to said sample plate means and
for generating plunger signals representative of the orientation of said plungers relative to said barrels, and
programmed computer means responsive to said longitudinal signals, to said mounting plate signals and to said plunger signals for generating a sequence of control signals to said longitudinal translation means, to said vertical translation means and to said plunger translation means to aspirate a first predetermined amount of liquid from said sample chambers into said respective pipette barrels, and to apply said liquid samples in each of said pipette barrels, where said lower tips of said barrels are at a position slightly above said microporous support medium onto corresponding spaces of said microporous support medium when placed on said lateral application space of said sample plate,
wherein said sample plate means includes a wash well adapted to contain wash liquid and a waste well longitudinally spaced from each other and from said sample chambers,
said programmed computer means generating a further sequence of control signals to said longitudinal translation means, to said vertical translation means and to said plunger translation means before aspirating liquid from said sample chambers,
to draw a second predetermined amount of wash liquid from said wash well into respective pipette barrels, and
to discharge said wash liquid into said waste well, and
wherein said sample plate means includes a longitudinal blotting space for applying a lateral blotting paper strip, said blotting space longitudinally separated from said sample chambers row, said wash well, said waste well and said lateral application space, and
said programmed computer means generating a further sequence of control signals to said longitudinal translation means, to said vertical translation means and to said plunger translation means after discharging said rinse liquid into said waste well, to blot the tips of said barrels on said blotting paper strip.

9. A sample plate adapted for use with automatic pipetting apparatus comprising a lateral row of individual liquid sample chambers and a lateral application space longitudinally separated from said liquid chamber row, said lateral application space adapted to receive a microporous support medium and
including a raised portion and a lower portion, said row of individual liquid sample chambers being disposed on said raised portion, said lateral application space being disposed on said lower portion and further comprising a wash well and a waste well longitudinally spaced from each other and from said sample chambers.

10. The sample plate of claim 9 further comprising a row of individual liquid dilution wells longitudinally spaced from said sample chambers.

11. A sample plate adapted for use with automatic pipetting apparatus comprising a lateral row of individual liquid sample chambers and a lateral application space longitudinally separated from said liquid chamber row, said lateral application space adapted to receive a microporous support medium, and
further comprising a wash well and a waste well longitudinally spaced from each other and from sample chambers, and
further including a longitudinal blotting space for applying a lateral blotting paper strip, said blotting space longitudinally separated from said sample chamber row, said wash well, said waste well and said lateral application space.

12. The sample plate of claim 11 including a raised portion and a lower portion, said row of individual liquid sample chambers being disposed on said raised portion, said lateral application space being disposed on said lower portion.

13. The sample plate of claim 11 including a raised portion and a lower portion, said row of individual liquid sample chambers, said wash well and said waste well being disposed on said raised portion, said lateral application space and said blotting space being disposed on said lower portion.

14. Automatic pipetting apparatus comprising,
a base,
track means disposed longitudinally on said base,
a carriage longitudinally movably disposed on said track means,
a sample plate removably disposed on said carriage, said sample plate including a lateral row of individual liquid sample chambers and a lateral application space longitudinally separated from said liquid chamber row, said lateral application space adapted to receive a microporous support medium, said sample chambers adapted to receive sample liquids,
a pipette frame mounted vertically on said base above

said carriage and said sample plate, said pipette frame having vertical mounting posts separated longitudinally from each other, each of said posts secured to said base,

a mounting plate assembly slidably guided by said posts and disposed laterally with respect to said sample plate and including,

a mounting plate having slidable guides disposed about said posts,

a barrel bar fixed to said mounting plate,

a plurality of microsyringe barrels having their heads secured in a row in said barrel bar and spaced corresponding to the spacing of said liquid chambers on said plate, said barrels being hollow with each having a lower tip,

a plunger bar vertically movably disposed above said barrel bar and having a plurality of micro-plungers secured thereto, each of said micro-plungers movably disposed within a corresponding microsyringe barrel, and

a plunger actuator plate vertically movable with respect to said mounting plate and carried by said mounting plate, said actuator plate removably secured to said plunger bar,

translation and signalling means for

moving said carriage longitudinally forward beneath said mounting plate assembly and generating carriage position signals indicative of said carriage position,

moving said mounting plate assembly vertically with respect to said base and generating mounting plate position signals indicative of mounting plate position, and

moving said plunger actuator bar and said plunger bar vertically with respect to said mounting plate and generating plunger bar position signals indicative of plunger bar position, and

programmed computer means responsive to said carriage position signals, to said mounting plate position signals and to said plunger bar position signals for generating a sequence of control signals to said translation means for translating said carriage, said mounting plate and said plunger bar to aspirate a first predetermined amount of liquid from said sample chambers into said respective pipette barrels, and to apply a droplet of said liquid samples in each of said pipette barrels onto corresponding spaces of said microporous support medium when placed on said lateral application space of said sample plate by precisely positioning said lower tips of said barrels at a small distance above said microporous support medium, said small distance being smaller than the diameter of a droplet of liquid sample which may be maintained on the end of said tips through surface tension forces of the barrel tips, whereby each droplet slightly touches said microporous support medium and is thereby relieved of its surface tension and is precisely transferred to said microporous support medium from each of said pipette barrels.

15. The apparatus of claim **14** wherein said sample plate includes a wash well and a waste well longitudinally spaced from each other and from said sample chambers,

said programmed computer means generating a further sequence of control signals to said translation means before aspirating liquid from said sample chambers,

to draw a second predetermined amount of rinse liquid from said wash well into respective pipette barrels, and

to discharge said rinse liquid into said waste well.

16. The apparatus of claim **14** wherein said translation and signalling means comprises,

carriage translation means responsive to carriage translative signals for longitudinally translating said carriage and said sample plate on said track means beneath said pipette assembly for operably translating said plate to at least a sample chamber position where said sample chambers are beneath said microsyringe barrels and to an application position where said microporous support medium is beneath said microsyringe barrels,

carriage signalling means for generating a sample chamber carriage position signal when said sample chambers are beneath said microsyringe barrels, and an application position signal where said microporous support medium is beneath said microsyringe barrels,

mounting plate assembly translating means responsive to up and down mounting plate assembly translation signals for vertically translating said mounting plate assembly between an upper position and a lower position, said upper position being sufficiently high to lift said microsyringe barrels above said plate operably allowing translation of said plate beneath said barrels, said lower position operably allowing insertion of said barrels into said fluid sample chambers when said plate is in said sample chamber position and operably allowing said barrels to be slightly above said microporous support medium when secured to said lateral application space of said plate,

mounting plate signalling means for generating a mounting plate upper position signal when said mounting plate is in said upper position and a mounting plate lower position signal when said mounting plate is in said lower position,

plunger actuator plate translating means responsive to up and down plunger actuator plate translation signals for vertically translating said plunger actuator plate and said plunger bar between a lower position where said micro-plungers are fully within said corresponding microsyringe barrels to a sample upper position where said micro-plungers are extended upwardly through said barrels operably drawing fluid into said barrels when said tips are immersed in fluid in said sample chamber,

plunger actuator plate signalling means for generating a plunger bar lower position signal when said plunger actuator plate and said plunger bar are in said lower position, and a plunger bar sample upper position signal when said plunger actuator plate and said plunger bar are in said sample upper position, and

electrical means for providing signal communication between said programmed digital computer and

said carriage translation means,

said mounting plate assembly translating means, and

said plunger actuator plate translating means, and for providing signal communication between said digital computer and

said carriage signalling means,

said mounting plate signalling means, and

said plunger actuator plate signalling means.

17. The apparatus of claim **16** wherein said digital

computer means includes a stored sequence of instructions for

generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said sample chamber position and removing said carriage translation signal when said sample chamber carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received,

said programmed digital computer means operably generating and applying said up plunger actuator plate translation signal to said plunger actuator plate translating means thereby translating said plungers from said lower position to said sample upper position and removing said plunger actuator plate translation signal when said plunger bar sample upper position signal is received, operably causing fluid in each of said sample chambers to be aspirated into said corresponding barrels,

said programmed digital computer means operably generating and applying said up mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said lower position to said upper position and removing said mounting plate assembly translation signal when said mounting plate upper position signal is received,

said programmed digital computer means operably generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said application position and removing said carriage translation signal when said application carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received, and

said programmed digital computer means operably generating and applying said down plunger actuator plate translation signal to said plunger actuator plate translating means thereby translating said plunger from said sample upper position to said lower position and removing said plunger actuator plate translation signal when said plunger bar sample lower position signal is received, operably causing fluid in each of said barrels to be applied to said microporous support medium when secured to said lateral application space of said plate.

18. The apparatus of claim **17** wherein

said sample plate further includes

a wash well and a waste well longitudinally spaced from each other and from said sample chambers, and

said plunger actuator plate translating means further includes a wash upper position, and

said plunger actuator plate signalling means further includes means for generating a plunger bar wash upper position signal when said plunger actuator plate and said plunger bar are in said wash upper position,

said carriage translation means further includes a wash well position and a rinse well position, and

said carriage signalling means further includes means for generating a wash well carriage position signal when said wash well is beneath said microsyringe barrels and a waste well carriage position signal when said waste well is beneath said microsyringe barrels,

said digital computer means includes a further stored sequence of instructions for before aspirating liquid from said sample chambers,

generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said wash well position and removing said carriage translation signal when said wash well carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received,

said programmed digital computer means operably generating and applying said up plunger actuator plate translation signal to said plunger actuator plate translating means thereby translating said plungers from said lower position to said wash upper position and removing said plunger actuator plate translation signal when said plunger bar wash upper position signal is received, operably causing fluid in said wash well to be aspirated into said barrels,

said programmed digital computer means operably generating and applying said up mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said lower position to said upper position and removing said mounting plate assembly translation signal when said mounting plate upper position signal is received,

said programmed digital computer means operably generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said wash well position and removing said carriage translation signal when said wash well carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received,

said programmed digital computer means operably generating and applying said down plunger actuator plate translation signal to said plunger actuator plate translating means thereby translating said plunger from said wash upper position to said lower position and removing said plunger actuator plate translation signal when said plunger bar lower position signal is received, operably causing

fluid in each of said barrels to be applied to said waste well, and

said programmed digital computer means operably generating and applying said up mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said lower position to said upper position and removing said mounting plate assembly translation signal when said mounting plate upper position signal is received.

19. The apparatus of claim **14** wherein said means for translating said carriage longitudinally forward and backward beneath said mounting plate assembly comprises

a carriage actuating motor fixed to said base, said motor having a rotatable output shaft,

a pinion gear fixed to said output shaft,

a rack gear secured to said carriage, said rack gear being in engagement with said pinion gear whereby the output shaft turning of said motor translates said carriage.

20. The apparatus of claim **14** wherein said means for translating said mounting plate assembly up and down with respect to said base comprises

a mounting plate actuator motor fixed to said mounting plate, said motor having a rotatable output shaft,

pinion gear means fixed to said output shaft,

a rack gear secured to said base, said rack gear being in engagement with said pinion gear means whereby the output shaft turning of said mounting plate actuator motor translates said mounting plate up or down with respect to said base.

21. The apparatus of claim **14** wherein said signalling means for generating mounting plate position signals indicative of mounting plate position includes

upper stop means secured to a member secured to said base,

upper trip switch means secured to said mounting plate and having a trip arm for engaging said upper stop means for operatively tripping said upper trip switch means when said mounting plate reaches its upper limit of travel,

lower stop means secured to said base, and

lower trip switch means secured to said mounting plate having a trip arm for engaging said lower stop means for operatively tripping said lower trip switch means when said mounting plate reaches its lower limit of travel.

22. The apparatus of claim **14** wherein said sample plate means further includes a row of individual liquid dilution wells longitudinally spaced from said sample chambers, said diluted wells adapted to receive dilution liquid,

said programmed computer means generating a further sequence of control signals to said longitudinal translation means, to said vertical translation means and to said translation signalling means for moving said plunger actuator bar and said plunger bar vertically with respect to said mounting plate for applying said first predetermined amount of liquid sample in each barrel to said dilution wells, applying a third predetermined amount of wash liquid from each barrel to said dilution wells, mixing the combination of said wash liquid and said liquid sample of said dilution wells, and aspirating an amount of diluted liquid samples from said dilution wells into said respective pipette barrels.

23. Automatic pipetting apparatus comprising,

a base,

track means disposed longitudinally on said base,

a carriage longitudinally movably disposed on said track means,

a sample plate removably disposed on said carriage, said sample plate including a lateral row of individual liquid sample chambers and a lateral application space longitudinally separated from said liquid chamber row, said lateral application space adapted to receive a microporous support medium, said sample chambers adapted to receive sample liquids,

a pipette frame mounted vertically on said base above said carriage and said sample plate, said pipette frame having vertical mounting posts separated longitudinally from each other, each of said posts secured to said base,

a mounting plate assembly slidably guided by said posts and disposed laterally with respect to said sample plate and including,

a mounting plate having slidable guides disposed about said posts,

a barrel bar fixed to said mounting plate,

a plurality of microsyringe barrels having their heads secured in a row of said barrel bar and spaced corresponding to the spacing of said liquid chambers on said plate, said barrels being hollow with each having a lower tip,

a plunger bar vertically movably disposed above said barrel bar and having a plurality of microplungers secured thereto, each of said microplungers movably disposed within a corresponding barrel of said microsyringes, and

a plunger actuator plate vertically movable with respect to said mounting plate and carried by said mounting plate, said actuator plate removably secured to said plunger bar,

translation and signalling means for

moving said carriage longitudinally forward beneath said mounting plate assembly and generating carriage position signals indicative of said carriage position,

moving said mounting plate assembly vertically with respect to said base and generating mounting plate position signals indicative of mounting plate position, and

moving said plunger actuator bar and said plunger bar vertically with respect to said mounting plate and generating plunger bar position signals indicative of plunger bar position, and

programmed computer means responsive to said carriage position signals, to said mounting plate position signals and to said plunger bar position signals for generating a sequence of control signals to said translation means for translating said carriage, said mounting plate and said plunger bar to aspirate a first predetermined amount of liquid from said sample chambers into said respective pipette barrels, and to apply said liquid in each of said pipette barrels from a position slightly above said microporous support medium whereby droplets of said liquid which forms on the tops of said barrels are transferred from said tips onto corresponding spaces of said microporous support medium when

placed on said lateral application space of said sample plate, and

wherein said sample plate includes a wash well and a waste well longitudinally spaced from each other and from said sample chambers,

said programmed computer means generating a further sequence of control signals to said translation means before aspirating liquid from said sample chambers,

to draw a second predetermined amount of rinse liquid from said wash well into respective pipette barrels, and

to discharge said rinse liquid into said waste well and wherein said sample plane includes a longitudinal blotting space for applying a lateral blotting paper strip, said blotting space longitudinally separated from said sample chamber row, said wash well, said waste well and said lateral application space, and

said programmed computer means generating a further sequence of control signals to said translation means after discharging said rinse liquid into said waste well,

to blot the tips of said barrels on said blotting paper strip.

24. The apparatus of claim **23** wherein said sample plate includes a raised portion and a lower portion, said row of individual liquid sample chambers, said wash well and said waste well being disposed on said raised portion, said lateral application space and said blotting space being disposed on said lower portion.

25. The apparatus of claim **23** wherein said sample plate includes a raised portion and a lower portion, said row of individual liquid sample chambers being disposed on said raised portion, said lateral application space being disposed on said lower portion.

26. The apparatus of claim **25** wherein said signalling means for generating carriage position signals indicative of carriage position includes

said carriage having a first longitudinal surface with notches disposed thereon, the longitudinal separation of said notches corresponding to the longitudinal position of said wash well, said waste well, said longitudinal blotting space, said sample chambers and said lateral application space,

a first trip switch secured to said track means on which said carriage moves, said switch having a first spring forced roller means for engaging said longitudinal surface whereby said switch is tripped when said roller is forced into a notch, operatively indicating that said wash well or said waste well or said longitudinal blotting space, or said sample chambers, or said lateral application space is beneath said microsyringe barrels.

27. The apparatus of claim **26** wherein said signalling means for generating carriage position signals indicative of carriage position includes

said carriage having a second longitudinal surface with at least one notch disposed thereon near the forward end of said carriage,

a second trip switch secured to said track on which said carriage moves, said second switch having a second spring forced roller means for engaging said second longitudinal surface whereby said switch is tripped when said second roller means is forced into said notch operatively indicating that said carriage has reached its rearward limit of travel.

28. The apparatus of claim **27** further comprising a limit switch means secured to the rear of said carriage at a position for engaging the forward end of said plate for indicating that said plate is in an operative position within said carriage.

29. The apparatus of claim **25** wherein said means for translating said plunger bar up and down with respect to said mounting plate comprises

a plunger plate motor fixed to said mounting plate, said motor having a rotatable output shaft,

pinion gear means fixed to said output shaft,

rack gear means fixed to said plunger actuator plate, said rack gear being in engagement with said pinion gear means whereby the output shaft turning of said plunger actuator plate motor translates said actuator plate and said plunger bar up or down with respect to said mounting plate.

30. The apparatus of claim **29** wherein

said plunger actuator plate motor is fixed to the rear side of said mounting plate,

said mounting plate includes two vertically plunger actuator plate guides with vertical grooves provided therein, said guides being fixed to the forward side of said mounting plate,

said plunger actuator plate is slidingly disposed within said vertical grooves on said mounting plate,

said mounting plate has vertical slots therein, and

said rack gear means fixed to said plunger actuator plate extend from said plunger actuator plate on the forward side of said mounting plate to said pinion gear means fixed to said output shaft of said plunger actuator plate motor on the rear side of said mounting plate.

31. The apparatus of claim **29** wherein said signalling means for generating plunger bar position signals indicative of plunger bar position includes

application cam means vertically adjustable on a vertical shaft secured to said plunger actuator plate,

wash cam means vertically adjustable on a vertical shaft secured to said plunger actuator plate,

a first trip switch means secured to said mounting plate and having a trip arm for engaging said application cam means for operatively tripping said first trip switch means when said plunger actuator plate reaches an upper application position, and operatively tripping said first trip switch means when said plunger actuator plate reaches an upper wash position,

lower cam means vertically adjustable on a vertical shaft secured to said plunger actuator plate, and

a second trip switch means secured to said mounting plate and having a trip arm for engaging said down cam means for operatively tripping said second trip means when said plunger actuator plate reaches its lower limit of travel.

32. Automatic pipetting apparatus comprising,

a base,

track means disposed longitudinally on said base,

a carriage longitudinally movably disposed on said track means,

a sample plate removably disposed on said carriage, said sample plate including a lateral row of individual liquid sample chambers and a lateral application space longitudinally separated from said liquid chamber row, said lateral application space adapted to receive a microporous support medium, said sample chambers adapted to receive sample liquids,

a pipette frame mounted vertically on said base above said carriage and said sample plate, said pipette frame having vertical mounting posts separated longitudinally from each other, each of said posts secured to said base,

a mounting plate assembly slidably guided by said posts and disposed laterally with respect to said sample plate and including,

a mounting plate having slidable guides disposed about said posts,

a barrel bar fixed to said mounting plate,

a plurality of microsyringe barrels having their heads secured in a row in said barrel bar and spaced corresponding to the spacing of said liquid chambers on said plate, said barrels being hollow with each having a lower tip,

a plunger bar vertically movably disposed above said barrel bar and having a plurality of micro-plungers secured thereto, each of said micro-plungers movably disposed within a corresponding barrel of said microsyringes, and

a plunger actuator plate vertically movable with respect to said mounting plate and carried by said mounting plate, said actuator plate removably secured to said plunger bar,

translation and signalling means for

moving said carriage longitudinally forward beneath said mounting plate assembly and generating carriage position signals indicative of said carriage position,

moving said mounting plate assembly vertically with respect to said base and generating mounting plate position signals indicative of mounting plate position, and

moving said plunger actuator bar and said plunger bar vertically with respect to said mounting plate and generating plunger bar position signals indicative of plunger bar position, and

programmed computer means responsive to said carriage position signals, to said mounting plate position signals and to said plunger bar position signals for generating a sequence of control signals to said translation means for translating said carriage, said mounting plate and said plunger bar to aspirate a first predetermined amount of liquid from said sample chambers into said respective pipette barrels, and to apply said liquid in each of said pipette barrels from a position slightly above said microporous support medium whereby droplets of said liquid which forms on the tops of said barrels are transferred from said tips onto corresponding spaces of said microporous support medium when placed on said lateral application space of said sample plate,

wherein said translation and signalling means comprises,

carriage translation means responsive to carriage translative signals for longitudinally translating said carriage and said sample plate on said track means beneath said pipette assembly for operably translating said plate to at least a sample chamber position where said sample chambers are beneath said microsyringe barrels and to an application position where said microporous support medium is beneath said microsyringe barrels,

carriage signalling means for generating a sample chamber carriage position signal when said sample chambers are beneath said microsyringe barrels, and an application position signal where said microporous support medium is beneath said microsyringe barrels,

mounting plate assembly translating means responsive to up and down mounting plate assembly translation signals for vertically translating said mounting plate assembly between an upper position and a lower position, said upper position being sufficiently high to lift said microsyringe barrels above said plate operably allowing translation of said plate beneath said barrels, said lower position operably allowing insertion of said barrels into said fluid sample chambers when said plate is in said sample chamber position and operably allowing said barrels to be slightly above said microporous support medium when secured to said lateral application space of said plate,

mounting plate signalling means for generating a mounting plate upper position signal when said mounting plate is in said upper position and a mounting plate lower position signal when said mounting plate is in said lower position,

plunger actuator plate translating means responsive to up and down plunger actuator plate translation signals for vertically translating said plunger actuator plate and said plunger bar between a lower position where said micro-plungers are fully within said corresponding microsyringe barrels to a sample upper position where said micro-plungers are extended upwardly through said barrels operably drawing fluid into said barrels when said tips are immersed in fluid in said sample chamber,

plunger actuator plate signalling means for generating a plunger bar lower position signal when said plunger actuator plate and said plunger bar are in said lower position, and a plunger bar sample upper position signal when said plunger actuator plate and said plunger bar are in said sample upper position, and

electrical means for providing signal communication between said programmed digital computer and

said carriage translation means,

said mounting plate assembly translating means, and

said plunger actuator plate translating means, and for providing signal communication between said digital computer and

said carriage signalling means,

said mounting plate signalling means, and

said plunger actuator plate signalling means,

wherein said digital computer means includes a stored sequence of instructions for

generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said sample chamber position and removing said carriage translation signal when said sample chamber carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position and said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received,

said programmed digital computer means operably generating and applying said up plunger actuator plate translation signal to said plunger actuator

plate translating means thereby translating said plungers from said lower position to said sample upper position and removing said plunger actuator plate translation signal when said plunger bar sample upper position signal is received, operably causing fluid in each of said sample chambers to be aspirated into said corresponding barrels,

said programmed digital computer means operably generating and applying said up mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said lower position to said upper position and removing said mounting plate assembly translation signal when said mounting plate upper position signal is received,

said programmed digital computer means operably generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said application position and removing said carriage translation signal when said application carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received, and

said programmed digital computer means operably generating and applying said down plunger actuator plate translation signal to said plunger actuator plate translating means thereby translating said plunger from said sample upper position to said lower position and removing said plunger actuator plate translation signal when said plunger bar sample lower position signal is received, operably causing fluid in each of said barrels to be applied to said microporous support medium when secured to said lateral application space of said plate,

wherein said sample plate further includes

a wash well and a waste well longitudinally spaced from each other and from said sample chambers, and

said plunger actuator plate translating means further includes a wash upper position, and

said plunger actuator plate signalling means further includes means for generating a plunger bar wash upper position signal when said plunger actuator plate and said plunger bar are in said wash upper position,

said carriage translation means further includes a wash well position and a rinse well position, and

said carriage signalling means further includes means for generating a wash well carriage position signal when said wash well is beneath said microsyringe barrels and a waste well carriage position signal when said waste well is beneath said microsyringe barrels,

said digital computer means includes a further stored sequence of instructions for before aspirating liquid from said sample chambers,

generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said wash well position and removing said carriage translation signal when said wash well carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received,

said programmed digital computer means operably generating and applying said up plunger actuator plate translation signal to said plunger actuator plate translating means thereby translating said plungers from said lower position to said wash upper position and removing said plunger actuator plate translation signal when said plunger bar wash upper position signal is received, operably causing fluid in said wash well to be aspirated into said barrels,

said programmed digital computer means operably generating and applying said up mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said lower position to said upper position and removing said mounting plate assembly translation signal when said mounting plate upper position signal is received,

said programmed digital computer means operably generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said wash well position and removing said carriage translation signal when said wash well carriage position signal is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received,

said programmed digital computer means operably generating and applying said down plunger actuator plate translation signal to said plunger actuator plate translating means thereby translating said plunger from said wash upper position to said lower position and removing said plunger actuator plate translation signal when said plunger bar lower position signal is received, operably causing fluid in each of said barrels to be applied to said waste well, and

said programmed digital computer means operably generating and applying said up mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said lower position to said upper position and removing said mounting plate assembly translation signal when said mounting plate upper position signal is received, and

wherein

said sample plate further includes a blotting space for applying a lateral blotting paper strip, said blotting space longitudinally separated from said sample chamber row, said wash well, said waste well and said lateral application space,

said carriage translation means further includes a blotting position, and

said carriage signalling means further includes means for generating a blotting carriage position signal when said blotting space is beneath said microsyringe barrels,

said digital computer means includes a further stored sequence of instructions for after discharging said rinse liquid to said waste well,

generating and applying said carriage translation signal to said carriage translation means thereby translating said carriage to said blotting position and removing said carriage translation signal when said blotting carriage position is received,

said programmed digital computer means operably generating and applying said down mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said upper position to said lower position and removing said mounting plate assembly translation signal when said mounting plate lower position signal is received, whereby said barrel tips are blotted when said blotting paper is disposed on said blotting space, and

said digital computer means includes a further stored sequence of instructions for

said programmed digital computer means operably generating and applying said up mounting plate assembly translation signal to said mounting plate assembly translating means thereby translating said mounting plate assembly from said lower position to said upper position and removing said mounting plate assembly translation signal when said mounting plate upper position signal is received.

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